#135 JANUARY 1988

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Dr. Dobb's Journal of Software Tools

FOR THE PROFESSIONAL PROGRAMMER

The 68030
How Hot Is It?

Focus on Macintosh Programming

New Mac Column

Languages:

0 38351 16562 8 01

ter than ever before!

4.0 uses logical units for separate compilation

Pascal 4.0 lets you break up the code gang into "units," or "chunks." These logical modules can be worked with swiftly and separately—so that an error in one module is seeable and fixable, and you're not sent through all your code to find one error. Compiling and linking these separate units happens in a flash because your compiling horsepower is better than 27,000 lines a minute.* And 4.0 also includes an automatic project Make.

4.0's cursor automatically lands on any trouble spot

4.0's interactive error detection and location means that the cursor automatically lands where the error is. While you're compiling or running a program, you get an error message at the top of your screen *and* the cursor flags the error's location for you.

4.0 gives you an integrated programming environment

4.0's integrated environment includes pull-down menus and a built-in editor. Your program output is automatically saved and shown in the output window. You can Scroll, Pan, or Page through all your output and know where everything is all the time. Given 4.0's integration, you can edit, compile, find and correct errors—all from inside the integrated development environment.

You'll never lose your mind, because 4.0 never loses your place

Whenever you re-load 4.0, it remembers what you and it were doing before you left. It puts you right back in the editor with the same file and in the same place as you were working last.

*Run on an 8 MHz IBM AT.

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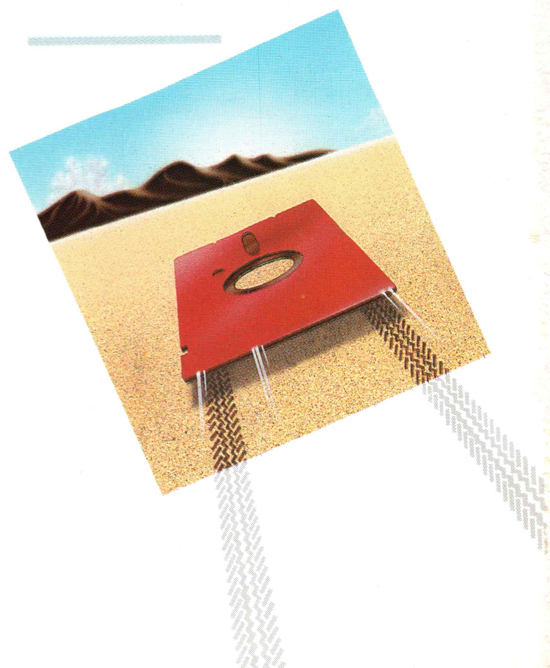

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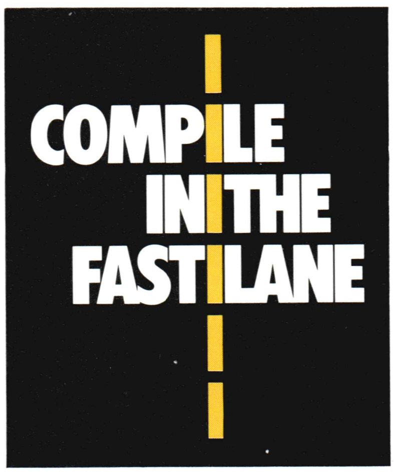

superiority also means commitment to detail, however painstaking, and that takes time. 4.0's predecessor, Turbo Pascal 3.0 is the worldwide standard, and with Turbo Pascal 4.0, we've bettered that standard. 4.0 is clearly the world's fastest development tool for the IBM® PS/2 series, PC's and compatibles—and the world's favorite Pascal compiler.

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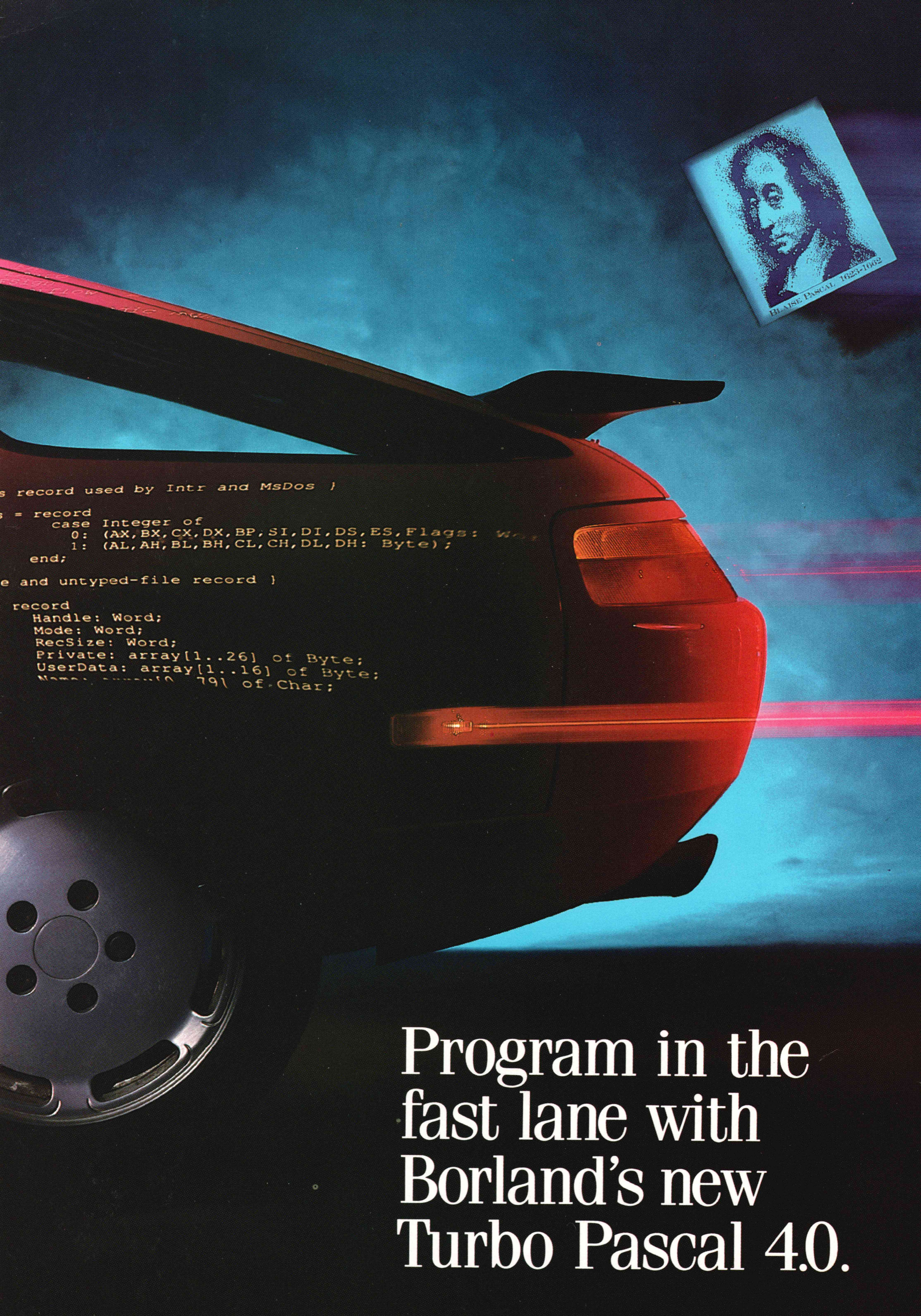
Blaise Pascal 1623-1662
s record used by Intr and MsDos }
s = record
case Integer of
0: (AX,BX,CX,DX,BP,SI,DI,DS,ES,Flags:
1: (AL,AH,BL,BH,CL,CH,DL,DH: Byte);
end;
e and untyped-file record }
record
Handle: Word;
Mode: Word;
RecSize: Word;
Private: array[1..26] of Byte;
UserData: array[1..16] of Byte;
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- Uses units for separate compilation
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- Interactive error detection/location
- Includes a command line version of the compiler

4.0 also

- Saves output screen in a window
- Supports 25, 43 and 50 lines per screen
- Generates MAP files for debugging
- Has graph units including CGA, EGA, VGA, MCGA, 3270 PC, AT & T 6300 & Hercules support
- Supports extended data types (including word, long integers)
- Does smart linking
- Comes with a free revised MicroCalc spreadsheet source code

4.0 is all yours for only $99.95

Sieve (25 iterations)

	Turbo Pascal 4.0	Turbo Pascal 3.0
Size of Executable File	2224 bytes	11682 bytes
Execution speed	9.3 seconds	9.7 seconds

Sieve of Eratosthenes, run on an 8MHz IBM AT

Since the source file above is too small to indicate a difference in compilation speed we compiled our GOMOKU program from Turbo Gameworks to give you a true sense of how much faster 4.0 really is!

Compilation of GO.PAS (1006 lines)

	Turbo Pascal 4.0	Turbo Pascal 3.0
Compilation speed	2.2 seconds	3.6 seconds
Lines per minute	27,436	16,750

GO.PAS compiled on an 8 MHz IBM AT

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JANUARY 1988 VOLUME 13, ISSUE 1

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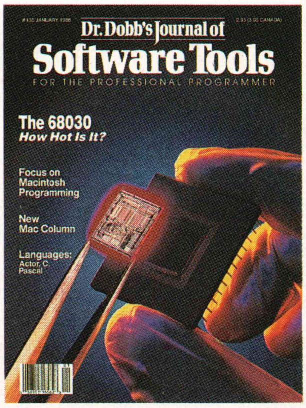


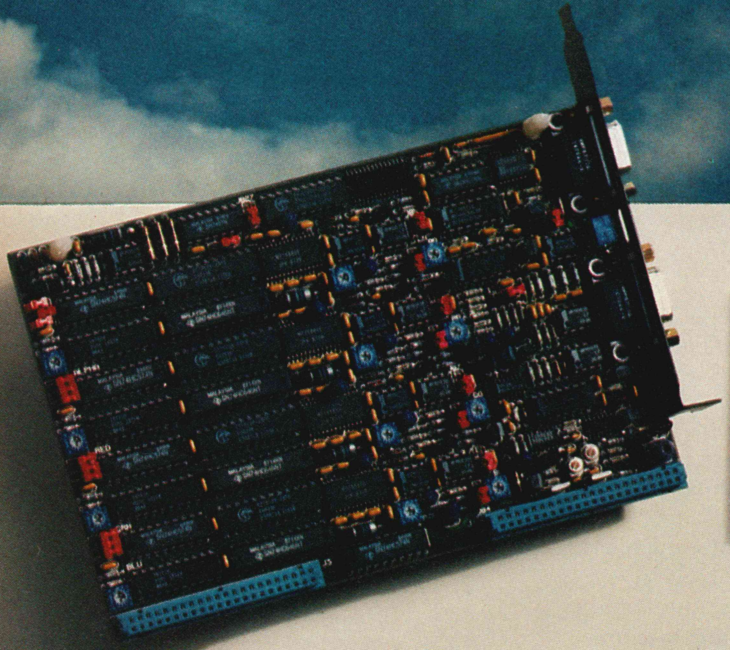
About the Cover

The Motorola 68030. Two googolplex of transistors, count them. Is it the Next Big Thing?

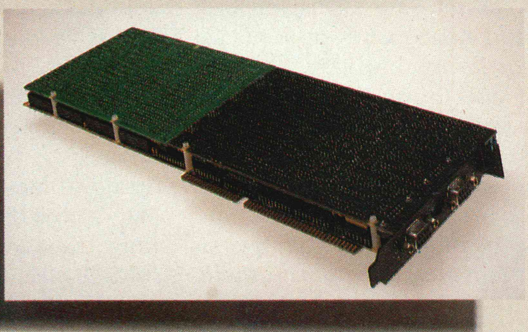
Next Issue

We don't normally comment on unreleased products, but since you are the soul of discretion, we'll tell you this much: the February release (Version 13.2) is now in alpha and will feature tools for debugging. Your SDK should arrive in 30 days and will include reviews of debugging tools and articles on debugging and a new section of short reviews called The Examining Room. The user interface will show minor bug fixes, and the delivery medium will again be high-bandwidth paper. And of course it's all upwardly compatible with the preceding 135 releases.

Introducing VISTA™ Videographics.



VISTA is a powerful single-slot videographics adapter which captures and displays video signals in real time.



Let's Get Specific.

We knew you couldn't resist seeing the facts, and frankly, our engineers wouldn't have it any other way. Here is an overview of VISTA's key features.

FEATURES:

- 4Mbytes of Video RAM on-board
- Texas Instruments' TMS 34010 GSP
- Flexible, programmable resolutions
- NTSC and PAL compatible
- Four 8-bit channels for real-time capture
- Fully integrated genlock
- Processor memory expandable in 2Mbyte increments to 12Mbytes
- Four 2K x 8-bit CMOS static RAM LUTs
- Display can be color-mapped, RGB, or a versatile combination of both
- Interlaced and non-interlaced display
- Binary and fractional programmable zoom capability, creates horizontal and vertical magnify or minify
- Smooth horizontal and vertical programmable panning, includes wrap-around and split screen
- Suggested Retail Price: $5995.

ADDRESSABLE RESOLUTIONS:

32 bits/pixel	16 bits/pixel	8 bits/pixel
1024x1024	2048x1024	4096x1024
512x2048	1024x2048	2048x2048
256x4096	512x4096	1024x4096

CAPTURE RESOLUTIONS:*

NTSC	PAL
(RS-170A)	(CCIR-624)
756x486	738x576
604x486	590x576
504x486	492x576
432x486	422x576

Resolutions are programmable; these are nominal ones for interlaced NTSC and PAL compatible.

DISPLAY RESOLUTIONS:*

NTSC	PAL	Interlaced	Non-Interlaced
(RS-170A)	(CCIR-624)		
1512x486	1476x576	1024x768	768x576
1008x486	984x576	(60 Hz)	(50 Hz)
756x486	738x576		
604x486	590x576	768x768	756x486
504x486	492x576	(80 Hz)	(60 Hz)

Resolutions are programmable; these are nominal ones.

COMPUTER REQUIREMENTS:

Host Type:	IBM PC AT and 100% Compatibles, Compaq 386, Apollo DN 3000-single-slot board
Data Bus:	16-bit or 8-bit (self-configuring)
Bus Clock:	6MHz to 12MHz
Power Consumption:	15 Watts

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EDITORIAL

Back in the late 1970s my best friend Renèe gave me a pocket calculator for my birthday. Needless to say, I was impressed. I was sure this modern gadget would make life a lot easier. It was a great little machine: ran on a 9-volt battery, had happy red lighted numbers, and had lots of blue buttons with serious mathematical symbols on them.

Of course, I err in speaking of this machine in the past tense; it still lives in my desk at home. I can't bear to throw it away. A few weeks ago my handy little calculator was the butt of several jokes from the very modern *DDJ* editors, and this caused me to pause and reflect a bit as we face a new year full of exciting technological advancements.

Motorola had a big shindig here in October to announce its new 68030 chip and gave out solar-powered calculators as a promotional prize. The guys on the staff generously donated the calculator to me so I could finally enter the 1980s. I appreciate this snazzy new tool, but somehow I can't bear to part with my old clunker.

January 1988. We've reached another year closer to 2000, and I find I have a hard time letting some of what made 1987 possible go without mention. Thanks to those great folks on the *DDJ* editorial staff who have gone on to bigger and better (?) things: Nick Turner, Deborah Hart, Vince Leone, and Levi Thomas. Also our columnists, who we hope will still send in an occasional piece of brilliant prose: Michael Ham, Ray Duncan, and Namir Shammas. (Namir is passing the baton of his Structured Programming column into the able hands of Kent Porter as of next issue.)

We have lots of exciting things in store for 1988, the first being the issue you hold in your hands, our annual 680x0 issue. In this issue we debut our new Macintosh column, To the Macs, by Stan Krute. Our editorial schedule for the rest of the year is as follows:

February—Debugging
March—Object-oriented programming
April—AI languages
May—Designing applications
June—Real-time programming
July—Distributed data (hypermedia)
August—Annual C issue
September—Software engineering
October—PostScript; Forth
November—Graphics and video
December—Operating systems

Give Tyler a call with any article ideas.

Starting in February, we will add Examining Room, a series of short product reviews, to *DDJ*'s traditional fare. We won't accept unsolicited reviews but invite you to join the team of "examiners." If you have any ideas, give Ron Copeland a call.

So now we're ready for a new year. I have my new calculator and you have your new magazine. But, being a sentimental sort, I'm determined to hang on to my relic of a calculator. I picture myself well into the 21st century, cuddled around the heat projection unit with my rosy-faced grandkids, all of them eager to hear another tale of days gone by. "Tell us about your first calculator again, Grandma," they will say. "Well," I'll reply, "Back in the late 1970s your Auntie Renèe gave me a pocket calculator for my birthday. . . ."

As we dive headfirst into a year filled with technological promises, let us not forget the people and forces that brought us to where we are today. Best wishes for 1988.

Sara Noah Ruddy

Sara Noah Ruddy
assistant editor

Dr. Dobb's Journal of Software Tools
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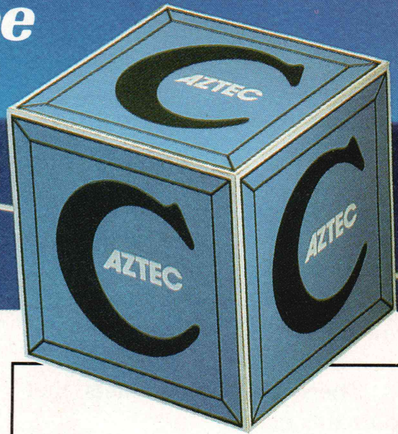

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RUNNING LIGHT

Tyler surfaced from writing this month's lead article just long enough to ask me to step onto this page and tell you what to expect from the arrival of HyperCard. Here goes:

1. Expect to see explosive growth in the number of "light" programmers in the Macintosh environment as a result of HyperCard, well beyond the effect of Turbo Pascal when it burst upon the PC environment. There are several facts that support this claim:

It's bundled. A million people will have HyperCard by the end of this year. Nearly all will actually use it (as an application).

The path from using HyperCard to writing your own programs in HyperTalk is smooth. The stages, from browsing to cut-and-paste application building to modifying existing scripts to writing short scripts of your own to developing full stackware applications with HyperTalk, may be the easiest gradient up to programming ever.

The pressure for a truly easy Mac development tool has been building for four years, and the floodgates are now open.

2. Expect prolific output from these "light" programmers. Again, there are several reasons to believe this:

Ease of programming. Even though it embodies principles unfamiliar to a BASIC programmer, HyperTalk is about as easy as BASIC or Pascal.

The power of the language. HyperTalk objects and messages are generally higher-level components than BASIC statements, so you can do more with fewer of them.

Expected aids to programming. Apple is developing enhancements that will make it easier to do more, including toolkits for controlling serial communications, AppleTalk communications, and interactive video. And there will be more public-domain and shareware programming aids like Andy Hertzfeld's PICT file importer. Commercial products will serve as lessons in programming, since the source is examinable.

3. Deduce from these expectations an overwhelming outpouring of stackware (as it is called). The evidence is already coming in: ten megabytes of shareware and public domain stackware was developed in the first three months after the announcement.

4. Expect the inevitable result: HyperGlut. While some amateurs will produce software that is far from amateurish, we will soon see unprecedented amounts of poor work. But obviously-bad software is just noise in the channel; the real HyperGlut will be in the stackware products that meet needs cheaply but poorly. That will, sadly, be used.

5. Expect the end of the predictable Macintosh user interface. That only worked while nearly everybody conformed nearly all the time.

6. Expect bad practices and poor programming style to become ingrained. This is a more depressing thought the more you dwell on it, because there are more ways to program badly with HyperCard than with BASIC. With HyperCard, snippets of code can reside in various places, such as attached to a button or to the card on which the button resides, and the inheritance structure of HyperCard allows events to drop through various objects, searching for a handler.

The object-oriented equivalent of spaghetti: what a concept.

Michael Swaine
editor-in-chief

ARCHIVES

Reaffirmation

"We who have had some degree of involvement with *DDJ* and People's Computer Company (PCC) modestly think of this publication as the lever which, with the slightest degree of pressure, just might move the world a bit. By serving the high end of the technological spectrum, some of our efforts do find their way by mysterious means into products and services which help people. This happens when one of our readers who sees the true potential of computers, and some piece of software we publish, puts them together in new ways." *Editorial, Marlin Ouverson, Editor,* DDJ, *December 1982.*

Tales of Future Passed

"The Xanadu Hypertext System is one of the most powerful systems in existence for managing text in a micro-to-mainframe database environment. It can store arbitrary numbers of documents and retrieve them on demand. It can organize them by using a highly generalized link facility and by allowing (and keeping track of) multiple users on the same system, and allow those users to work with each other on a common document base. It can grow indefinitely over a large distributed network with minimal degradation in performance. . ." Roger Gregory, *"Xanadu - Hypertext from the Future,"* DDJ, *January 1983.*

Pretty Is As Pretty Does

"The laws of entropy insure that the line numbers of a debugged and operational BASIC program give the appearance of having been selected by a KENO machine. In fact, while several texts detail how the boundary conditions of a KENO game lead to predictable outcomes, finished programs seldom exhibit this property. Many a time I have spent an extra hour retyping a finished program while spacing the line numbers evenly just to make it look good." *"Renumbering & Appending BASIC Programs on the Apple II Computer,"* Steve Wozniak, DDJ, *February 1978.*

Dr. Dobb's Journal of Computer Calisthenics & Orthodontia
Running Light Without Overbyte

LETTERS

Optimum Performance?

Dear *DDJ*,

Either Richard Relph's article on optimizing compilers for C (August 1987) has a slight error, or I'm going to have a lot of trouble with my code if I start to use one. I believe the example of common subexpression elimination he refers to as block range optimization is at least module range and could be program range.

Under the K & R definition of C, a two-dimensional array is not necessarily a continuous block of storage. An expression such as *a[i][j]* refers to the *j*th element of the block pointed to by *a[i]*. The element *a* is an array of pointers to appropriate objects. This permits arrays in which rows can have different sizes and in which rows can be switched by swapping pointers and permits arrays to be built up dynamically during execution. Consequently, the identification of *d[i][j]* with *d[0][t0]* where $t0 = i*10 + j$ is not always correct.

Even if we can be assured that the dimensions of *d* will be 10×10 when *copy( )* is called, if the storage of *d* was allocated one row at a time (as is often the case in my programs), there is no assurance that *d[i][j]* can be addressed as in the example. There is even no assurance that the address of *d[i][j]* will bear the same relationship to that of *d[0][0]* as *s[i][j]* will to *s[0][0]*. In the particular example given, that assurance is provided by the declarations of *d* and *s*. (Even that assurance could be compiler implementation dependent, though I know of no compilers for which it would not be correct.) But these were globals, declared outside the function, so the optimization indicated requires at least module-level information and in other cases might require program-level information.

Any optimizing compiler that streamlines multidimensional array addressing in this way will either have to incorporate information beyond the function being optimized or it will have to restrict this technique to certain arrays declared within the function.

Thanks for an interesting article. Keep up the good work.

Clyde Schechter
116 Pinehurst Ave., Apt. D-63
New York, NY 10033

Better (or Worse) Standard

Dear *DDJ*,

I had mixed emotions after reading Richard Relph's description of the forthcoming ANSI C standard in the August 1987 issue. As a programmer working almost exclusively in C, I like the idea of replacing local dialects with a common language, and I like many of the proposed enhancements. I am disturbed, however, by the move to merge the library routines into the definition of the language. At present, the C language is unique in not including library routines as part of the specification, which I think is the right approach.

For example, the article mentions that library function names and macros are to be reserved words, to eliminate the possibility of programmers substituting their own functions for standard ones. I have often substituted such routines to good effect while debugging a program, however. Similarly, it can be useful to set breakpoints on routines such as *strcpy( )*, which will be impossible if the compiler is free to substitute in-line code for my subroutine call.

Although I agree that the library functions should be standardized, making them part of the syntax itself hurts the language. The justification for this seems to be that it makes it easier to optimize the code, but it is a poor trade to take away capabilities in order to go easy on the compiler!

*"Good Grief—now **They've** penetrated **Our** networks!"*

At present, I know what's going on when I call *strcpy( )* in any compiler, and if I want to speed up my program, I can write in-line code myself. With ANSI C, programmers won't know how to write efficient code without knowing which compiler will be used to compile it. This improves portability? Perhaps the ANSI committee needed a few more members who buy compilers along with those who write them.

William F. Linke
286 Dunhams Corner Rd.
East Brunswick, NJ 08816

Richard Relph replies:

Mr. Linke's letter makes a key observation. The C library is now "standardized." Without this change, program portabil-

(continued from page 10)

ity is unobtainable. It should be noted, however, that library routines are not mandated for freestanding environments, such as embedded systems.

I have some difficulty with his final paragraph. He seems to be wanting both maximal speed and maximal portability, a desirable goal, I agree. The two are often at odds with one another, however. Perhaps a solid example would help here. Suppose I need to perform a string copy operation. I could either call *strcpy* or code it in-line. Mr. Linke's assumption is that, by coding it inline, he would get the best performance. This is not necessarily true, even with today's non-ANSI compilers. Most libraries implement *strcpy* in assembly language, using instructions that most C compilers cannot normally generate, such as *REP MOVSB* in the 8086. Therefore, the programmer already doesn't know what's most efficient. Mr. Linke further assumes that he "knows what's going on when I call *strcpy()* in any compiler." Is he aware that some existing compilers perform in-line expansion of key library functions? MetaWare and Microsoft's both do this, and I'm sure others will follow.

By reserving the library function names for the compiler, the compiler can do several things that would otherwise be impossible. First, the library itself can call library routines. If users were allowed to replace *strcpy*, for example, other library routines such as *printf* could not call it. This essentially means that for the normal case when programmers do not replace *strcpy*, but do call it, the library must include two copies, one with some strange name for the library itself and one for the user to call.

Second, the library can be granularized at other than the function level. Although it is nice to have a library that is function granular, some machines cannot support libraries with so many "chunks." If the implementor thought that *strcpy* and *memcpy* made a reasonable pair and put them in a single module, and the programmer replaced *strcpy* but called *memcpy*, what could the linker do?

Last, the compiler can now replace some calls to functions with in-line assembly-language code, taking into account the actual parameters. This is optimal efficiency, allowing the insertion of the assembly-language version of *strcpy* in the code, saving the call and return overhead.

At the risk of being taken literally and in the extreme, let me say that leaving operations at as high a level as possible is always desirable. If I can call *strcpy*, or write it in-line, I will pick the call—for efficiency, for maintenance, for clarity, and for standardization.

Finally, let me say that these compiler features are what people will probably start basing their buying decisions on. This is a net plus. People who want what Mr. Linke wants will probably be able to get it and people who don't will be able to get something else.

```
254 10          UNITS INCHES
254 12 *   10   UNITS FEET
254 36 *   10   UNITS YARDS
10  1           UNITS CENTIMETERS
1000  1         UNITS METERS

\ Usage:
10 FEET    . <cr>  3048  ok
3 METERS   . <cr>  3000  ok
\ ........................
\ etc.
```

Example 1: *Conversion program using the defining word* UNITS

```
VARIABLE  <AS>      0 <AS> !
: AS  -1 <AS> ! ;
: UNITS  CREATE  SWAP , ,  DOES>  D@  <AS> @
       IF  SWAP  THEN  */  0 <AS> ! ;
BEHEAD' <AS>     \ TO MAKE IT LOCAL FOR SECURITY

\ UNIT DEFINITIONS REMAIN THE SAME.
\ Usage:
10 FEET . <cr>  3048  ok
3048 AS FEET .  <cr>  10 ok
```

Example 2: *Code to convert back to input units when outputting*

Dimensional Data Types in Forth

Dear *DDJ*,

This letter is an addendum to Eric Lundquist's comment (Letters, August 1987) on Do-While Jones' article "Dimensional Data Types" (in Ada). His astonishment at the lengthy code required to implement this simple idea in Ada is, of course, justified. As a theoretical physicist and accident consultant who uses dimensioned data every day of my life, I was equally astounded.

Experienced Forth programmers, on the other hand, must have smiled indulgently, murmured "What fools these mortals be!", and passed on. As a fairly recent convert to Forth (and a heavy user of this language for scientific computing), however, I cannot pass up this opportunity (we recent converts tend to be zealots) to exhibit how easily dimensioned data can be implemented in Forth. Perhaps Mr. Lundquist—who feelingly alludes to the advantages of assembly language—will then be sufficiently piqued to give Forth a try.

Suppose you need to input distances in various units. For example, U.S., English, and Continental police reporting accidents might wish to use inches, feet, and yards, or centimeters and meters. Rather than writing different versions of a program, and making users worry about which one they are using, it is simpler to write one program and make unit conversions part of the grammar. Thus, for example, you might keep all internal lengths in millimeters and convert as follows:

```
: INCHES 254 10 */ ;
: FEET [ 254 12 * ] LITERAL 10 */ ;
: YARDS [ 254 36 * ] LITERAL 10 */ ;
: CENTIMETERS 10 * ;
: METERS 1000 * ;
```

The usage would be:

```
10 FEET . <cr> 3048 ok
```

These are more definitions than necessary, of course. A better alternative

(continued on page 126)

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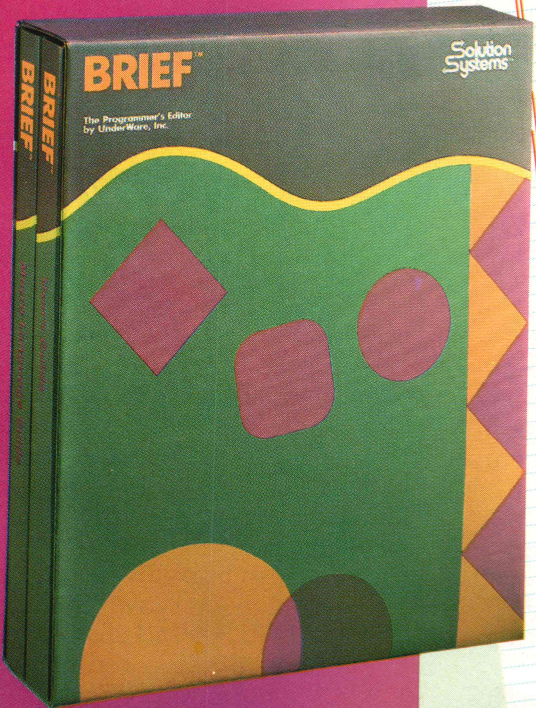

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386 vs. 030: The Crowded Fast Lane

Picking the fastest CPU can be difficult when not even the benchmarks agree

by Tyler Sperry

Past issues of *DDJ* have detailed the introduction and rise of Intel's 80386 microprocessor and its related software in some detail. The ability of 386 machines to maintain compatibility with MS-DOS software while also giving substantially faster performance is something we all can respect. The 80386 isn't the only CPU that can lay claim to the title of fastest microprocessor, however. Recently, Motorola introduced the latest member of its 68000 line—the 68030—with performance claims that would leave the 80386 in the dust. Obviously, this claim bears some investigation.

The 68000 Gets Respectable

Like many of you, my first experience with a 68000-based computer was the original 128K Macintosh. *Disillusionment* is the mildest term I'd use for my first encounter. Despite the promise of a superfast processor with lots of 32-bit general-purpose registers and plenty of memory (128K!), I was able to go back to my CP/M machine without regret. By burdening the CPU with updating the video and emulating a disk controller, the Mac seemed a perfect demonstration of Grosch's Law[1]; the CPU might be inherently faster than 8-bit machines, but you'd never be able to prove it by the performance.

In the last few years we've seen the introduction of a number of machines that have delivered on the promise of the 68000. The Mac line has matured to produce the 68020-equipped Macintosh II that rivals the performance of the IBM PC AT. At the other end of the spectrum, Sun Microsystems has had enormous success with Unix boxes based on the 68000 and its descendants. Indeed, once you subtract a few proprietary CPUs (from IBM and DEC), workstations are powered almost exclusively by the 68000.

When not programming or reviewing hardware and software, Tyler Sperry works at his day job as Editor of DDJ.

The Paradox of the Installed Software

Fine, you say, but what difference does that make when there are more than 8 million DOS machines out there? And what about the 80386? Doesn't it blow away the 68020?

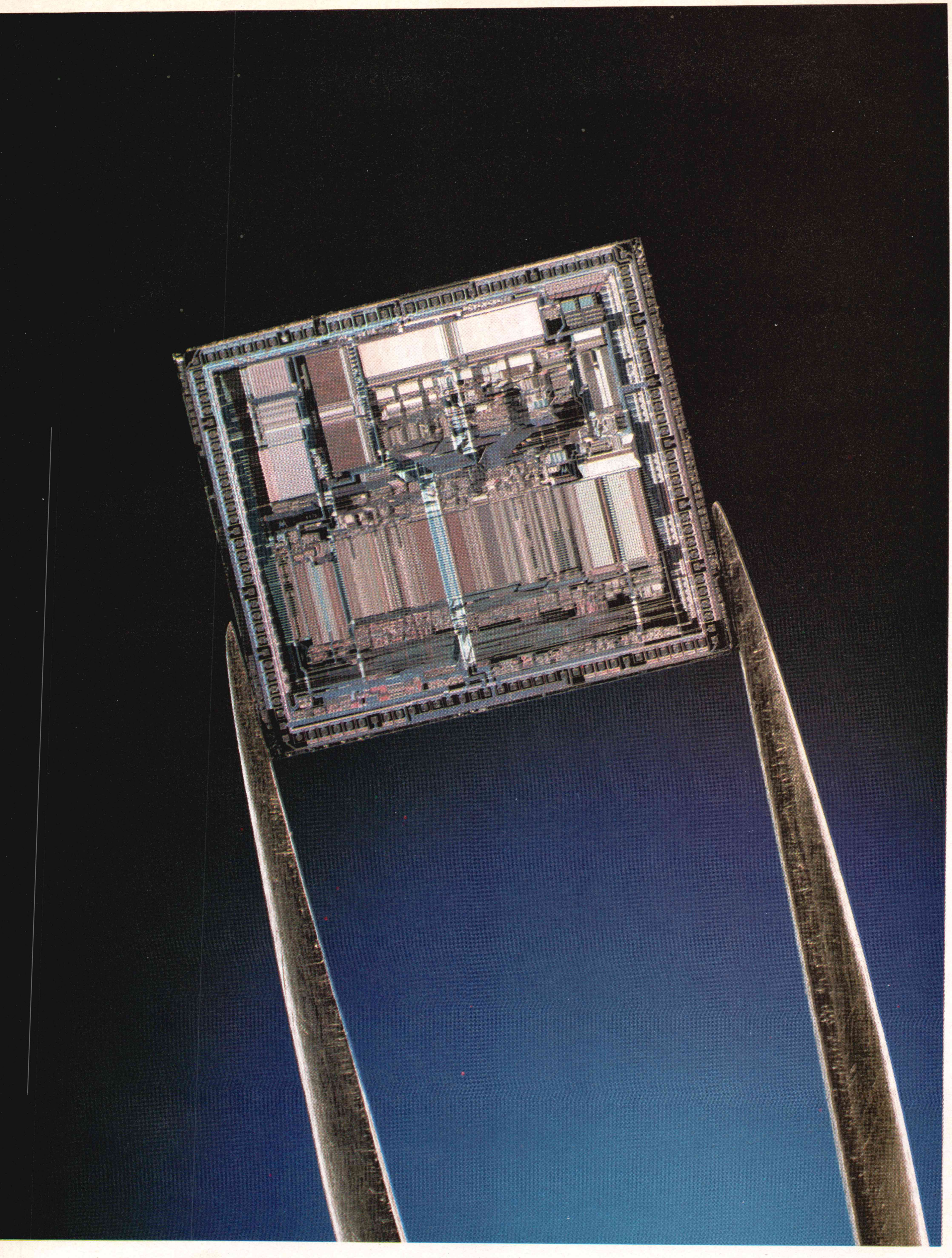
On the first point, I am happy to say that this article is concerned with comparing the latest offerings of the Intel and Motorola lines, not with software and hardware marketing. Still, those questions often come up in a discussion of the technical merits of competing CPUs. (The AMD 29000 looks to be a fantastic chip, but when will you get to program one?) For now, let it suffice to say that:

- Any machine hoping to become the new standard in the personal computer marketplace will have to address the huge software "inertia" of the millions of DOS machines and their software compatibility demands.
- The high-performance CPUs coming out in the next few years will probably make this point moot by providing PC emulation at speeds meeting or exceeding an AT. (This software already exists for Unix boxes.)
- Even if software emulation isn't suitable, 286 "clone cards" are becoming increasingly easier to come by on a variety of buses.

Apples and Oranges

At first glance, it might seem simple to compare the performance of the 80386 and the 68030. Just set up a test jig with some memory and the two CPUs and run some benchmarks. Although that approach might have worked with 8-bit CPUs (the infamous "good old days"), there are a few problems when you get to the new 32-bit processors.

There's memory, for example. Do you furnish the processors with the fastest static RAM available and let them run flat out, or do you run with a "typical" system



(continued from page 17)

(dynamic RAM) and slow the CPUs down with wait states? Arguments can be made on either side.

In the case of the 68030/80386 controversy, this concern has actually been addressed by the chip manufacturers. Both CPUs have provisions for handling the common problems associated with using dynamic RAM slower than the CPU can handle. Both chips have a provision for "burst mode" access, for example, which allows contiguous bytes of memory to be accessed without the delays normally associated with address setup and decoding. In some respects these two CPUs are more similar than different. There is one significant difference in their approach to handling memory access, however, that has a substantial impact on performance.

Cache As Cache Can

Let's take a brief detour down memory lane (so to speak). Back in the days of the 6502 and 8080, access to memory was slow but relatively straightforward. If the processor wanted an instruction, it went out to the memory bus and fetched one.

This procedure began to change with the introduction of the Intel 8088. One of the features of the 8088 was a 4-byte prefetch instruction queue that attempted to separate memory bus activity from computation time. Program instructions were moved from memory into a prefetch queue and then acted upon. Although this sped things up a bit, it was of limited usefulness. (See this month's Letters for more on the subject.) Indeed, the less charitable have referred to the prefetch queue as the prefetch bottleneck.

Eager to please, the engineers at Intel improved things in subsequent Intel designs: the 80386 has a 16-byte prefetch instruction queue. (A simplified schematic is shown in Figure 1a.)

Motorola's attempts at speeding things up became noteworthy with the introduction of the 68020. The 68020 does not have an instruction queue but rather a 256-byte instruction cache. Once an instruction is loaded into the cache from memory, it need not be reloaded unless it's been replaced by a more frequently used instruction. Thus, a small, tight loop can run entirely from on-board cache memory and result in much faster performance. An instruction queue, on the other hand, is by definition limited to operating as an instruction pipeline; any branch taken forces the reloading of the queue.

As you might expect, the addition of an instruction queue can substantially improve a processor's performance. The amount of improvement will, of course, depend on how many tight loops there in your code. (Yet another reason to be wary of small benchmarks.) Thayne Cooper and some engineers at Sperry ran both the 68020 and 80386 through some modified *EDN* benchmarks and published the results in *IEEE Micro*.[2] While a 16-MHz 80386 was able to surpass a 16-MHz 68020 with a disabled cache, enabling the cache better than halved the original 68020 benchmark times. (The cached 68020 beat the 80386 in all tests except the string search benchmark.)

Lies, Damn Lies, and Benchmarks

Now, given those benchmarks results, it'd seem pretty clear cut. The performance improvement of boosting the clock speed to 20 MHz should be pretty much the same for either chip. Score them neck and neck—with the edge to the 68020—and we're done, right?

Alas, as my friend Jerry Pournelle would say, it isn't all that simple. The benchmarks done by Cooper were modified 16-bit *EDN* benchmarks, performed on special hardware. The hardware was designed to keep things as

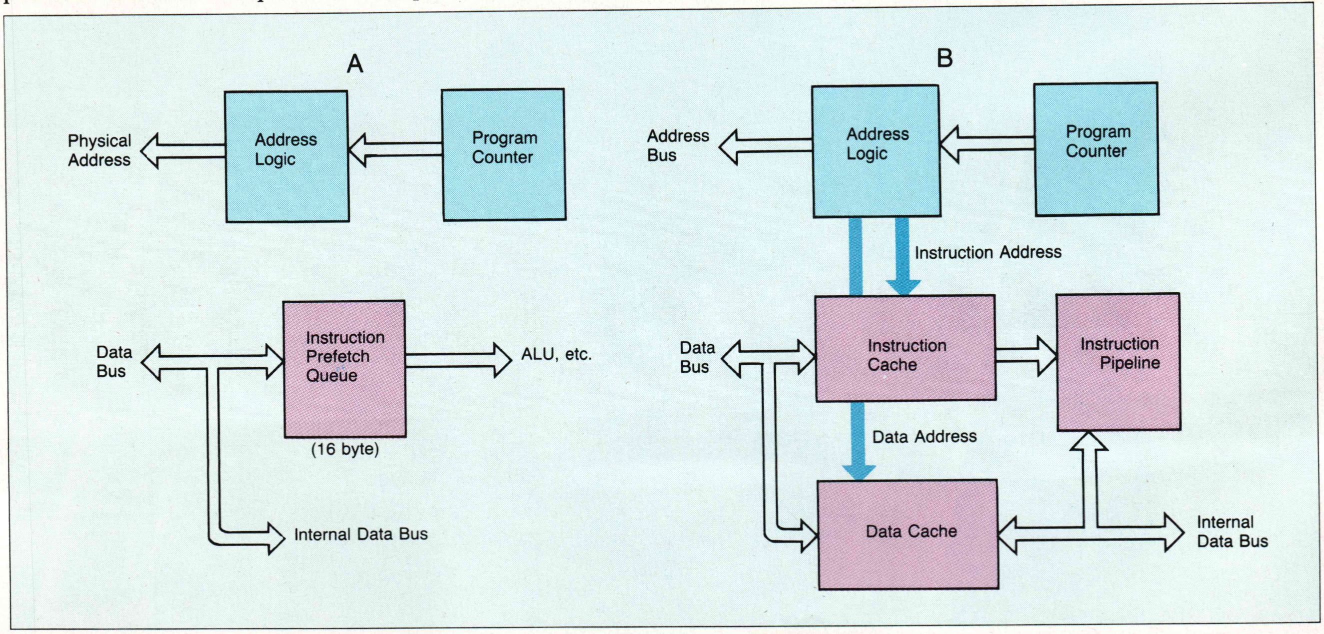


Figure 1: *Simplified view of the memory interface for the 80386 and 68030. The 80386 (a) has a 16-byte prefetch instruction queue. The 68030 (b) features a modified Harvard architecture with separate 256-byte caches for both instructions and data.*

(continued from page 18)

equal as possible for the various processors (the 32032, 32100, and the 80286 were also tested).

Unfortunately, life isn't always fair: your choice of machines will often not include units comparable in all aspects except CPU; sometimes the benchmarks used in a test don't always bear a strong resemblance to your actual application and environment; and the compiler used can impact your results tremendously.

Consider the case of poor Richard Grehan at *Byte*.[3] He took several varieties of 386 computers and accelerator cards, compiled some benchmarks, and ran them. Then he did the same thing for a Mac II and some 68020 accelerator cards in different environments. If you have some experience with benchmarks (or if you read *Byte* regularly), you can anticipate what he found: the 80386 outperformed the 68020 in the majority of tests.

How to explain this? Well, there are some things to note in the *Byte* article benchmarks. First of all, these tests were performed with the intent to test mathematical performance. The only nonmathematical tests were the infamous Sieve and a quicksort routine. As the commercials say, your actual milage may vary.

Second, although Grehan tried to use the same compiler vendor for all machines, this wasn't always feasible. Some of the compilers used for two of the 68020 machines gave substantially better times than the Macintosh compiler used for the other tests, and in fact these times were in the same neighborhood as the best 80386 time (a 16-MHz Compaq 386 with an 80387 coprocessor, in case you were wondering).

The lesson here is unfortunately all too clear. The best benchmark is your target application, ported to the prospective machine. Depending on the optimizations offered by the compiler and individual machine peculiarities, you'll find benchmarks vary widely—there are too many confounding variables for a categorical statement that one chip is better than another. Still. . . .

Going Back to School

After all that discussion and equivocation on the subject of the 68020 vs. the 80386, you'd expect making a clear statement on the relative performance of the 68030 wouldn't be too plausible. After all, as of this writing, there aren't many 68030 machines available to test. (Both Apple and NeXT are rumored to be working on 68030 designs; both refuse to comment on unannounced products.) In reading through the literature, though, I came across some things that can let us make a pretty good guess.

To start with, the 68030 implements a modified Harvard architecture along with expanded caching. A Harvard architecture machine uses separate address and data buses for both instructions and data; in the 68030, a modified Harvard scheme is employed, in which separate buses are used internally and then multiplexed for access to the system. Figure 1b, page 18, shows a simplified schematic of the 68030's memory interface.

386 vs. 030

(continued from page 20)

Notice that there are now two 256-byte caches: one for instructions and one for data. Given the radical improvement a cache made in the 68020's performance, you can see why Motorola is proudly trumpeting the 68030 as "twice the microprocessor." Of course, it didn't hurt that the chip runs at a clock speed of 25 MHz.

Conclusions

Given that the 80486 is still quite a ways away, Intel would probably like you to believe that a 16-MHz 80386 is equal to a 20-MHz 68020 and that its 20-MHz 80386 is equal (or better) to a 25-MHz 68030. Motorola, as you might expect, has a different view: a fast 68020 is a match for any 80386 and the 68030 blows away an 80386 at any speed.

Aside from the engineer's instinctive distrust of (other people's) benchmarks, and despite the vendor charges and countercharges concerning the benchmarks, there are some clear lessons:

- Other things being equal, an 80386 and a 68020 will perform at roughly the same rate: bloody fast.
- A 68030 at 25 MHz will probably be faster than any 80386 you find. How much faster, though, will depend a great deal on your software and compiler.
- If your application is primarily number crunching, a fast math coprocessor is essential and its presence or absence will probably swamp other aspects.
- A weak compiler can mislead you on the performance of a given system. Conversely, a highly optimizing compiler can completely destroy the value of a poorly constructed benchmark.[4]
- Beware of virtual machines. Today's 5-MHz PC clone is faster than a 50-MHz 80486 box that won't be shipping for another six months.

Notes

1. Ted Nelson, *Computer Lib/Dream Machines* (Microsoft Press, 1987).
2. T.C. Cooper, W.D. Bell, et al., "A Benchmark Comparison of 32-Bit Microprocessors" *IEEE Micro*, vol. 6, no. 4 (August 1986).
3. Richard Grehan, "The New Generation: A Closer Look" *Byte* (September 1987).
4. Richard Relph, "Optimizing Compilers for C" *DDJ*, vol. 12, no. 8 (August 1987).

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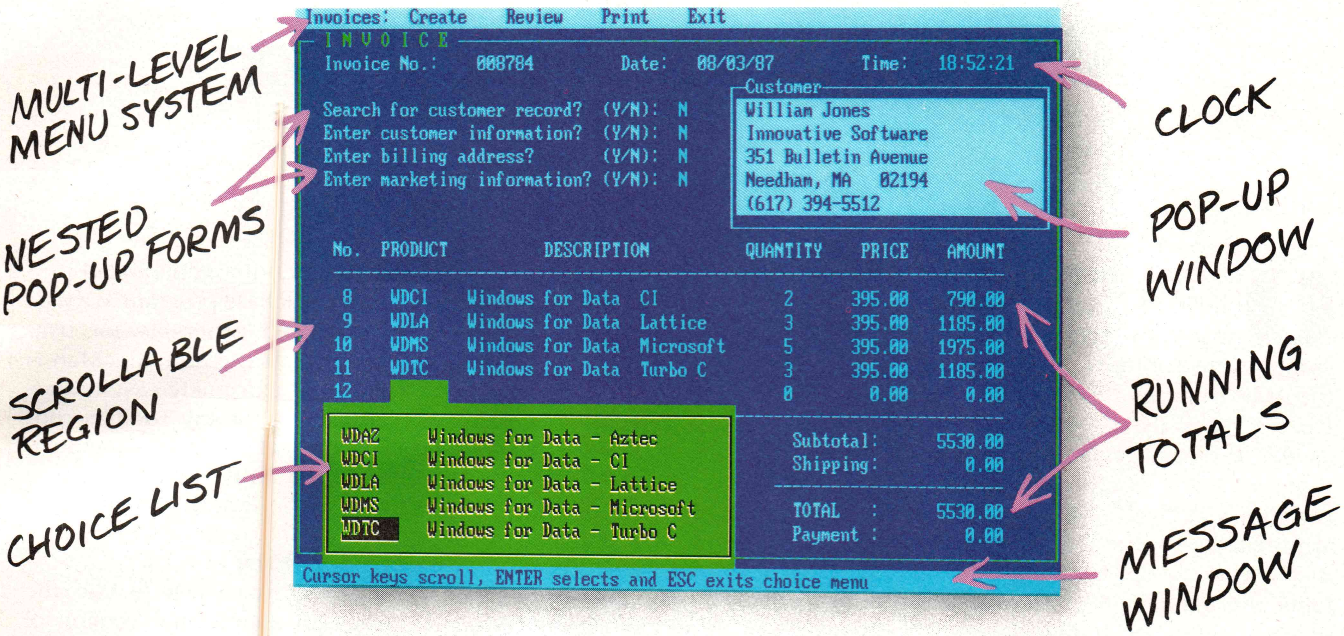

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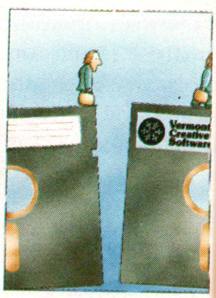

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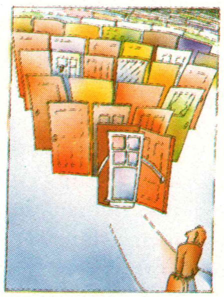

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A Programmers' Database for the Macintosh Toolbox

by Abdullah Al-Dhelaan and Ted G. Lewis

Putting Inside Macintosh inside your Macs

One challenge to writing application software for Apple's Macintosh is the complex environment. Programming the Mac requires the use of an extensive set of ROM routines known as the Toolbox. These routines, although largely responsible for the machine's radical ease of use, add appreciably to the Mac programmer's work load. The Toolbox contains more than 600 routines, and many of them are required in writing even the smallest application. Most programmers find themselves continually referencing Apple's massive documentation, *Inside Macintosh*, for technical details on the numerous procedures, functions, and data structures of the Toolbox.

At first, using *Inside Macintosh* as a handy reference manual might seem a minor chore. It has a good index and is divided into five logical volumes. Unfortunately, information retrieval time becomes a dominant factor in the development process, and it quickly becomes obvious that an on-line, electronic means of retrieval is needed.

Our program, MacMan, is an on-line programmers' database that contains much of the key information found in *Inside Macintosh*. Programmers can use MacMan to fetch the name, parameters, comments, and often-needed descriptions of the Toolbox routines. This information can be accessed from within an editor as an aid to documentation or can be used simply as a way to acquire a better understanding of the inner workings of the Mac. Currently, the database contains more than 500K of text describing the Toolbox routines as well as many other useful facts about the Macintosh.

Abdullah Al-Dhelaan and Ted Lewis work in the Computer Science Dept. Oregon State University, Corvallis, OR. 97331.

The design goals for MacMan were simple: the program should be convenient to use, and it should contain useful information. Above all else, we knew that it had to be convenient to be compelling. Convenient meant both simple and fast. We knew that programmers wouldn't accept MacMan if they had to learn a new language or come to grips with a complex database system.

We also knew that the information contained had to be accurate and useful. We could have written the information in a more useful form than that of *Inside Macintosh*, and we could have selected information from various other sources. We rejected these alternatives, however, because we didn't want to risk introducing errors or to accidentally include ambiguous passages.

We therefore elected to copy carefully selected passages directly from *Inside Macintosh*. We worked hard to convince Apple Computer to let us use the copyrighted contents of *Inside Macintosh* specifically to avoid errors or misrepresentations of fact.

MacMan is not a generalized programmers' database program. We willingly sacrificed generality for user convenience. As a result, MacMan is both fast and extremely easy to use. The description of any Toolbox routine can be retrieved from the 500K database file and displayed in a window—all in less than a second.

Using MacMan

There are a two ways to use the database: an abbreviated version of MacMan can be installed in the system file as a desk accessory (DA), or a full-fledged application version of the program can be launched from the desktop.

A DA is a special program that can run concurrently in memory with another application. Most *DDJ* readers are familiar with the concept of DAs from TSR (terminate-and-stay-resident) programs such as SideKick, but these products illustrate an ad hoc solution to the problem of writing a DA. In contrast to the PC, the Mac allows DAs to be integrated into the Macintosh operating environment. It's this integration that we'll be emphasizing in this article. We'll describe the MacMan desk accessory and then show how it was implemented using the Macintosh Toolbox functions.

Two simple access methods are provided through the menu: Find by Name and View by Category (see Figure 1, page 25). Find by Name, as you might expect, retrieves the desired Toolbox routine by its name. If you don't know the routine's name, you can select the View by Category menu item (see Figure 2, page 25). View by Category lets you select one of the 28 managers as a category

and then browse through it. When you browse through a category, the Toolbox routine names are displayed in alphabetical order—selecting one of them results in a full display of the routine's description (see Figure 3, below). If MacMan is unable to find a Toolbox routine, it reports the error and asks if it should browse all the routines that begin with the same letter (see Figure 4, page 26).

The subject of this article, DAMacMan, is a version of the database that runs as a desk accessory. Before delving into the inner structure of DAMacMan, however, we'll first review the structure of the typical Macintosh application and how it relates to calling DAs.

The Structure of Mac Applications

Every Macintosh application consists of at least one event loop that determines what operations the application's user is allowed to perform. The event loop must handle all user interactions such as mouse clicks, menu selections, and icon manipulations. The existence of an event loop makes Macintosh applications resemble real-time control programs more than traditional interactive sequential programs.

Every well-behaved application must include a Toolbox call to *SystemTask* so that periodic actions, such as updating the system clock, can be performed by the Macintosh operating system. In Example 1, page 26, we show only one *SystemTask* call for each pass through the main event loop, but in general *SystemTask* should be called at least once every 16 clock ticks (a tick is defined as a 60th of a second). If the application is doing a lot of work on each pass of the event loop, then the *SystemTask* call should be made more often.

The application calls *GetNextEvent* each time through the event loop in order to find out what events have taken place since the previous pass. *GetNextEvent* calls the *SystemEvent* routine, which simply intercepts the stream of events, and if an event belongs to the DA, that event is shuttled to the DA rather than to the application.

Suppose the user selects the DA menu and presses the mouse button; this will cause a *mouse-down* event (*mouseDown*) to be generated by calling the *DoMouseDown* routine. The application programmer must write the *DoMouseDown*

Figure 1: *A Toolbox routine is retrieved by giving either its name or its manager category.*

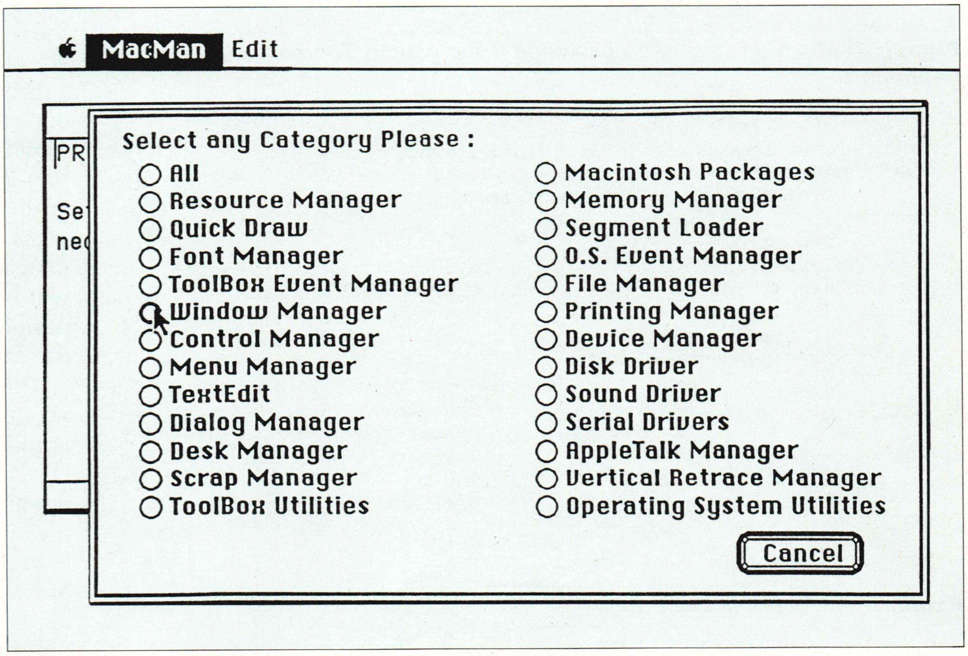

Figure 2: *The MacMan catagories cover the ROM routines for both the user interface Toolbox and operating system.*

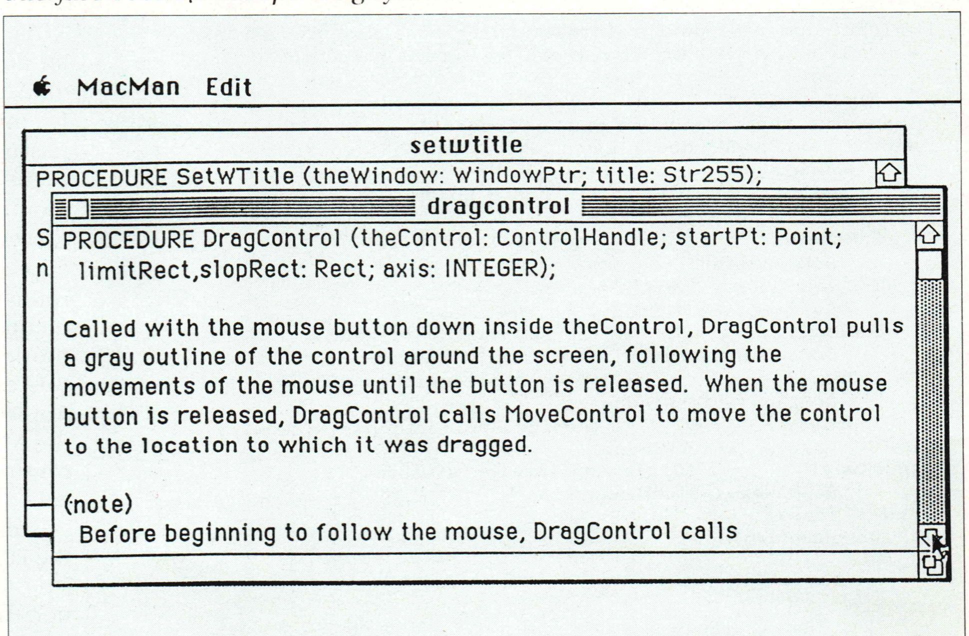

Figure 3: *An example of a displayed Toolbox routine*

Figure 4: *MacMan reverts to browsing if the named Toolbox routine can't be found.*

```
PROCEDURE SimpleEventLoop( Var Event: EventRecord );
   Var UserAction    : Boolean;     {Has the user done something??}
          Finished          : Boolean;     {Exit When User Quits}
   Begin
          Repeat
          SystemTask;                   {To support periodic events}
          UserAction := GetNextEvent( AllEvents, Event);
                                             {To invoke SystemEvent}
          If UserAction then            {Handle the event...}
          Case Event.what Of
                      mouseDown: DoMouseDown(Event, Finished );
                      KeyDown        : DoKeyDown(Event, Finished );
                      ActivateEvt    : DoActivate (Event, Finished );
                      UpDateEvt      : DoUpdate(Event, Finished );
          End;        {Case}
          Until Finished;               {terminate the program?}
End;                                    {SimpleEventLoop}
```

Example 1: *A simple event loop*

```
PROCEDURE DoMouseDown(       Var Event       : EventRecord;
                                    Var Finished: Boolean );
Var
   whichWindow : WindowPtr;{Window that mouse was pressed in}
   whereIs    : INTEGER;       {Part of screen where mouse
                                                  was pressed}
Begin {DoMouseDown}
   {Where on the screen was mouse pressed?}
   whereIs := FindWindow ( Event.where, whichWindow);
   Case whereIs Of
      InDesk:                 {In Empty Space...}
         {Do nothing};
      InMenuBar:              {Menu Selection...}
         DoMenuClick;
      InSysWindow:   {Aha! In a DA... }
         SystemClick ( Event, whichWindow);
      InContent:              {In Application's window...}
         DoContent (whichWindow);
      InDrag:                 {Drag Application's window...}
         DoDrag (whichWindow);
      InGrow:                 {Resize Application's window...}
         DoGrow (whichWindow);
   InGoAway:         {Close Application's window...}
         DoGoAway (whichWindow)
   End ·  {case}
End; {DoMouseDown}
```

Example 2: *The DoMouseDown routine*

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(continued from page 25)

routine in such a way as to call the appropriate DA. The code necessary to do this is shown in Example 2, below.

The events that are diverted from the application to the DA are channeled into the DA processing code in two ways, as shown in the *DoMouseDown* procedure. The first way is through the *SystemClick* Toolbox routine, as shown in case *InSysWindow* of *DoMouseDown*, and the second way is through a menu selection.

When a mouse-down event occurs in a system window, the application code should call *SystemClick*. If the mouse-down event is in a DA window, *SystemClick* takes care of processing the event instead of the application. This case will be discussed later as it is what happens when the DA is already on the screen.

The mouse-down event could also occur in the DA menu (under the apple), which would mean that the DA is to be activated (this is called opening the DA). This is the case we are most interested in for the time being. If the user has selected the MacMan DA, for instance, then the application program must handle the opening of the DA from the *DoMenuClick* routine, shown in Example 3, page 30.

As shown in *DoMenuClick*, when an application calls the *MenuSelect* (or *MenuKey*) Toolbox routine, a call is made to *SystemMenu*, which passes the event to the DA (if the event is a mouse-down in the DA menu). The DA must then handle the event and return a zero to the application. Otherwise, *MenuSelect* returns a long integer containing the menu number in its *HiWord* and the item number in its *LoWord*. In this case, when the user selects the Apple menu, and within this menu, the MacMan DA, the *DoAppleChoice* routine (see Example 4, page 30) is called to activate the DA.

This sequence of actions opens the DA and prepares it for use alongside the currently running application. In summary, the sequence is:

- A mouse-down event occurs and

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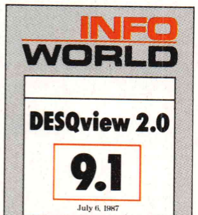

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(continued from page 26)

is handled by the event loop.

- The *DoMouseDown* routine decides the event is *InMenuBar*.
- The *DoMenuClick* routine decides the event is an *AppleMenu* event.
- The *DoAppleChoice* routine decides the event is a DA selection.
- The name of the DA (*accName*) is obtained and the DA opened.

The Structure of a Mac DA

A DA is a "mini-application" that can be run concurrently with a Macintosh application. A DA cannot exceed 32K of executable machine code and data and is installed in the start-up disk system file using a Macintosh utility program called the Font/DA Mover. Once a DA is installed, it no longer has a file or an icon visible from the desktop. Instead, the user opens a DA by selecting it from the standard Apple menu, which by convention is the first in the menu bar.

After a DA has been opened, its window, if any, is displayed on the desktop and it becomes the active window. To close a DA, the user can click the DA's close box (in its own title bar), or another program can call the function *CloseDeskAcc* to close it. The DA will then disappear and the frontmost window will become the active window.

A desk accessory may have a menu of its own, which will be added to the menu bar when it is active and deleted when it is not. The *Cut*, *Copy*, and *Paste* commands in a standard Edit menu can be used by an active DA. They are very useful for copying and pasting between the DA and the application or another DA.

Writing a DA

Writing a DA is a lot more difficult than writing a "plain vanilla" application because a DA has no main procedure, no main event loop to obtain events, and no global variables.

Technically, a DA is known as a Macintosh device driver, and each DA is required to have three special procedures: *Open*, *Close*, and *Ctl* (for control). These procedures are called directly by the operating system through a special table called the DA Header.

Each of these procedures requires two formal parameters of type *Device Control Record* and *Parameter Block Record*. A *Device Control Record* is created when a DA is opened and destroyed when it is closed. A *Parameter Block Record* is created by the operating system each time any of the three routines is called. It is used to inform the DA about the purpose of the call.

The Macintosh operating system calls *Open* whenever a DA is selected from the Apple menu and calls *Close* whenever the close box on the title bar of the DA's window is clicked or *CloseDeskAcc* is called by some other program. Between these two calls, the system will call *Ctl*.

What DA Procedures Do

When the *Open* procedure is called to open the DA, it will:

1. Create the DA window, if there is one
2. Set the *WindowKind* field of the window's *WindowRecord* to the DA's driver reference number. (This field is set so the operating system can call the correct DA when an event

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occurs in a DA window.)
3. Set the *DctlWindow* field of the DA's *Device Control Entry Record* to the window pointer.
4. Allocate space for global data in the field *dctlstorage* of the *Device Control Entry Record.*

```
PROCEDURE DoMenuClick;       {  Handle mouse-down event in
                                               menu bar.  }
Var
   menuChoice        : LONGINT;     {Menu ID and item number}
   theMenu    : INTEGER;     {Menu ID of selected menu}
   theItem    : INTEGER;     {Item number of selected item}

Begin {DoMenuClick}

   menuChoice := MenuSelect (TheEvent.where);
      if menuChoice <> 0            {Application, or DA?}
      Then begin                    {Application...}
          theMenu := HiWord(menuChoice);{Get menu ID}
          theItem := LoWord(menuChoice);{Get item number}
          Case theMenu Of
              AppleID:       {Make selection from Apple menu}
                      DoAppleChoice (  GetMenu( AppleID ), theItem);
              FileID:        {Make selection from File menu}
                      DoFileChoice  ( GetMenu( FileID ), theItem);
          EditID:     {Make selection from Edit menu}
                      DoEditChoice  ( GetMenu( EditID ), theItem)
   End;   {case}
   End;   {if}
End;          {DoMenuClick}
```

Example 3: *The DoMenuClick routine*

```
PROCEDURE DoAppleChoice (Var  AppleMenu: MenuHandle;
                                    theItem    : INTEGER);
Var
   accName    : Str255;        {Name of desk accessory}
   accNumber  : INTEGER;       {Reference number of desk accessory}

Begin {DoAppleChoice}
Case theItem of
   AboutItem:        {Application's About... Item}
      DoAbout;
   otherwise {Must be a DA...}
      Begin
      GetItem (AppleMenu, theItem, accName);
                                                {Get accessory name}
      accNumber := OpenDeskAcc (accName)    {Open desk accessory}
      End {otherwise}
 End {case}
End;         {DoAppleChoice}
```

Example 4: *The DoAppleChoice routine*

```
Procedure DoEditChoice (...., theitem : Integer);
  { Handle choice from Edit Menu }
   Begin                    { DoEditChoice}
      if Not SystemEdit (theItem-1)
     Then
         Case theItem of
            cutitem      : DoCut;
            copyitem   :  DoCopy;
            Pasteitem  : DoPaste;
     end; { Case}
End;      {DoEditChoice}
```

Example 5: *The DoEditChoice routine*

5. Initialize the global data.

Close is called to close the DA. It first disposes of its window and stores nil in the *DctlWindow* field of the *Device Control Entry Record*, then it disposes of any global data it might have allocated in the *dctlstorage* field of the *Device Control Entry Record*.

Ctl is called to enable the DA to handle the action indicated by the *csCode* field of the *Parameter Block Record*. There are nine such actions, as shown in Table 1.

Passing Text

An application must have the standard Edit menu if it wants to support passing text to and from DAs. The order of items in this menu is important, but the menu can be made longer by adding items at the end.

A DA program consists of at least three special procedures called Open, Close, and Ctl.

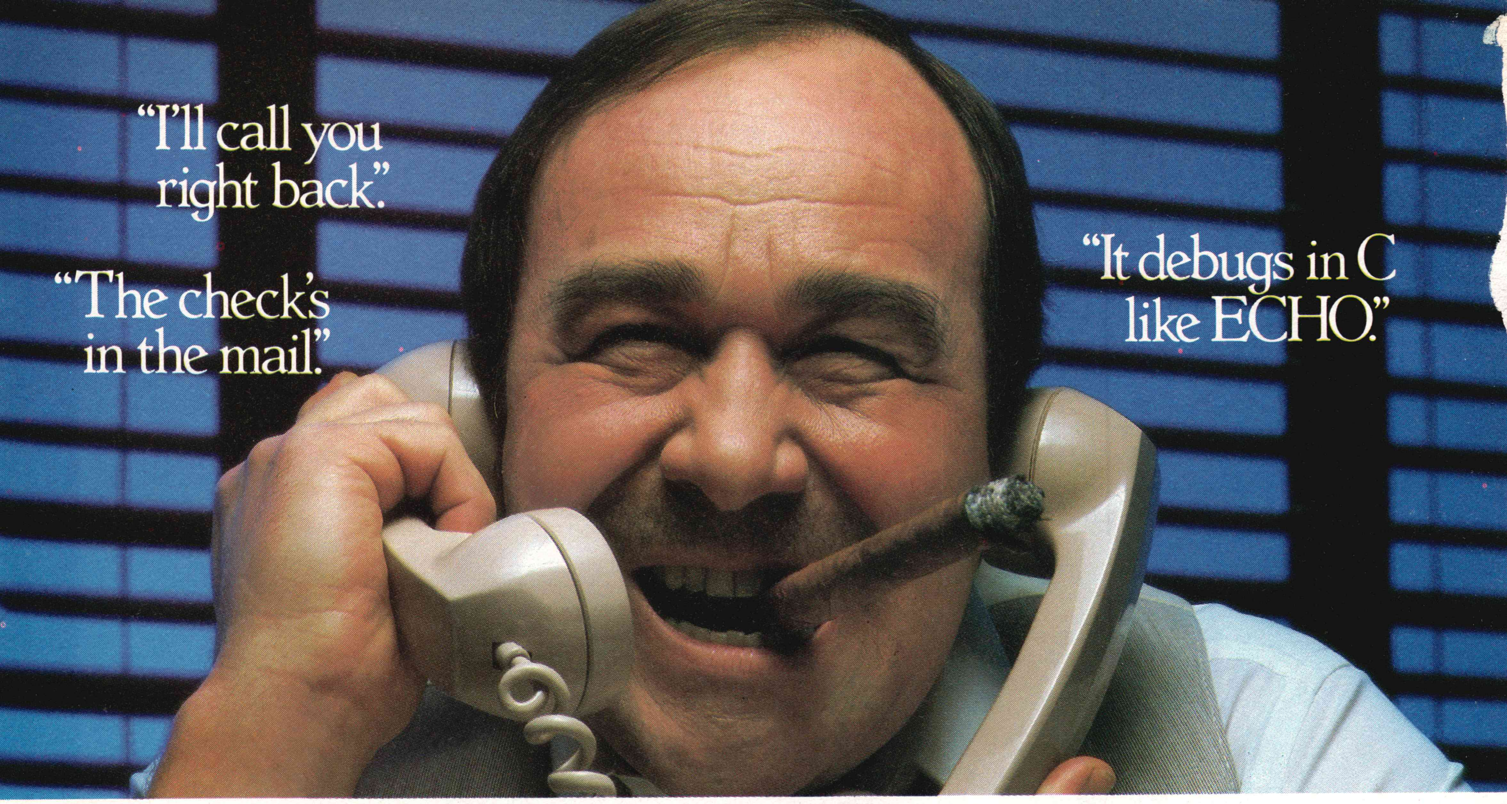
The standard Edit menu contains Undo, Cut, Copy, Paste, and Clear. When a user chooses one of these commands, the application must call Toolbox routine *SystemEdit* from within *DoEditChoice* (see Example 5, page 30). The menu items are numbered 0 through 5 internally, which is why we subtract 1 from the item number (*theItem–1*) in the routine shown in Example 5. If the active window is a system window (that is, a DA window), then *SystemEdit* will return false and the application will process the command as usual. Otherwise, *SystemEdit* will shuttle the event on to the DA for command processing and return true.

Resources for DAs

The code for the DA is not a *CODE* resource, as it is for applications, but is a *DRVR* because a DA is actually a device driver. The Macintosh resource compiler RMaker can be used to create a *DRVR* resource by reading the *CODE* resource created

1. AccEvent	An event (update, activate, keyboard, . . .)
2. AccRun	Do a periodic action
3. AccCursor	Change cursor shape
4. AccMenu	Menu selection
5. AccUndo	The Undo editing command
6. AccCut	The Cut editing command
7. AccCopy	The Copy editing command
8. AccPaste	The Paste editing command
9. AccClear	The Clear editing command

Table 1: *DA actions allowed by Ctl*



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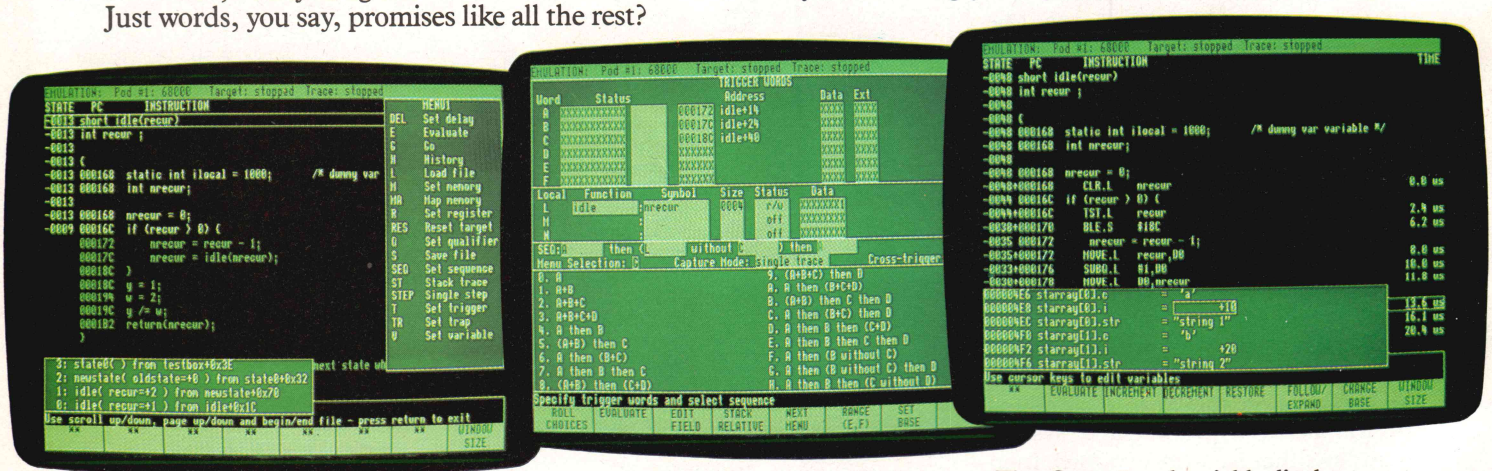

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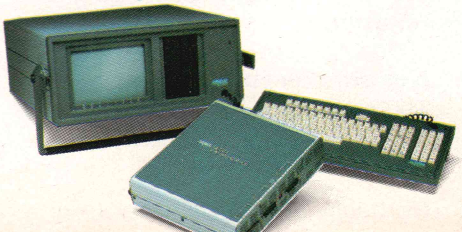

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MAC DATA BASE
(continued from page 31)

by the linker with ID=1 and converting it to a *DRVR* resource. This is done by including the following lines in the resource file prior to compiling it with RMaker:

```
Type DRVR = PROC
  Deskacc,16
DeskaccFile
```

The name *DeskaccFile* is the linker's output file for the DA file, and *Deskacc* will be used as the DA name to appear under the Apple menu once the DA is installed in the system file. The resource ID then becomes the DA's driver reference number and is used by the operating system to implement the DA and is also used for owned resources.

Owned Resources

A range of 32 resource IDs has been reserved for each DA *DRVR* resource ID, so they are called owned resources. A special numbering convention is used to associate owned system resources with the resources they belong to. For any particular DA, this range is computed by adding $C000 and 32 times the driver reference number—for example, if the driver reference number is 16, then the range is –15,872 through –15,857.

When the DA is moved from its own file or a system file into a system file, all its resources for windows, menus, and so on must be transferred along with the code for the DA into the destination system file. If the destination system file already has a DA with the same *DRVR* resource ID, the Font/DA Mover will renumber it and all of its owned resources. Part of the DAMacMan resource file is shown in Listing One, beginning on page 48.

In summary, a DA program consists of at least three special procedures called *Open*, *Close*, and *Ctl*. The DA program may have other procedures as well, but it has no main body. You might think of the DA program as a module consisting of its own constants,g types, variables (Listing Two, page 48), and procedures (Listing Three, page 50). *Open* is called by *OpenDeskAcc* (from the running application); *Close* is called by *Ctl* (when the DA terminates itself) or *ExitToShell* (when the application terminates); and *Ctl* is called each time the application calls *SystemEvent*.

Listing Three shows these three procedures for DAMacMan, but keep in mind that these procedures must always exist for every DA even if they are tailored for some other purpose. In addition, because DAs are limited to 32K in size, the sophistication of a DA is restricted to miniature utility functions such as displaying the keyboard and so on. Implementing the MacMan database retrieval code was quite a challenge because of this limitation.

The Structure of DAMacMan

When DAMacMan is opened from the Apple menu, it looks in the system disk to see if the files it requires are present. If a file named Manual and another file named MMIndex are not present, DAMacMan will display an error dialog.

DAMacMan's related files are Manual, text from *Inside Macintosh* (the database); MMIndex, the index

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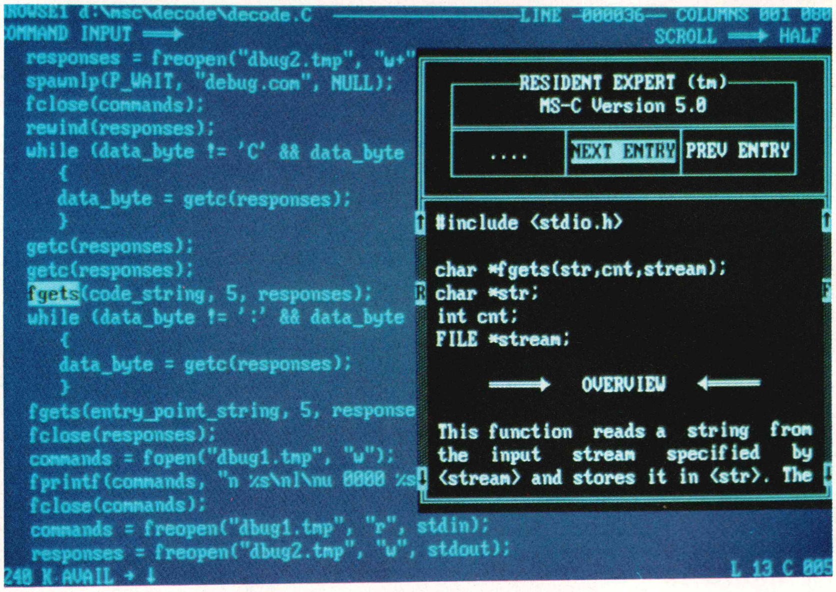

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The RESIDENT EXPERT System

MAC DATA BASE
(continued from page 33)

into the database; MMSize.int, a temporary file used to generate a version of DAMacMan; MMConfig, a DAMacMan software tool for generating versions and MMLock, which locks and unlocks files.

Manual, the database, consists of two parts: the MacMan distribution text and the MacMan information that contains all the procedures and functions defined in *Inside Macintosh*, organized as follows:

```
\ name
   category#
   body
```

where *name* is the name of the procedure or function, *category* is the section of *Inside Macintosh* in which it is defined, and *body* is the information about the procedure or function.

MMLock is a MacMan tool whose job is to lock and unlock the files that are generated

The index file, MMIndex, contains records sorted with respect to name, each record having the following form:

```
Record
   name : String[25];
   start : longint;
   length : Integer;
   man : Integer;
end;
```

where *name* is the name of the procedure or function, *start* is the starting position relative to the beginning of the manual, *length* is the length of the text that belongs to this procedure or function, and *man* is an integer representing the section or manager of *Inside Macintosh* where this function or procedure is defined.

The MMSize.int file contains the statement:

```
Const MaxRec =    ;
```

The blank will be filled in by the MacMan tool MMConfig, prior to compiling MacMan. The value of *MaxRec* is equal to the number of entries in Manual. The DAMacman main program is shown in Example 6, page 41.

MacMan Tools

DAMacMan is configured and maintained through the use of a set of tools that must be applied each time the database is changed. MMConfig is a tool for constructing the index file for the database and the Pascal compiler *include* file that contains the size of the database. In addition, the integrity of the database is maintained by locking the database files using the MMLock program, described later.

MMConfig reads the file Manual and writes the ordered file MMIndex with records of the form:

```
Record
   name : String [25];
```

MAC DATA BASE
(continued from page 35)

```
  start : Longint;
  length : Integer;
  man : Integer;
end;
```

MMConfig performs the following steps:

1. It forms a record for each procedure or function in Manual.
2. It store a pointer to each of the records in an array of pointers.
3. It sorts the array with respect to name.
4. It creates the file MMIndex, to be read whenever MacMan is started up, and writes the sorted records to it.
5. It creates the file MMSize.int, which will be included during compilation of DAMacMan.
6. It locks the files Manual and MMSize.int so they cannot be opened by a user who is not supposed to have access to these files.
7. It stamps these files with the appropriate icons.

MMConfig is run to create MMIndex and MMSize.int after Manual has been edited the first time and whenever Manual is updated.

Finally, MMLock is a MacMan tool whose job is to lock and unlock the files that are generated by MMConfig.

Data Structures

As mentioned, after Manual has been constructed by entering all desired text into the database, MMConfig is run to generate the files MMIndex and MMSize.int. Then DAMacMan can be compiled and run. When DAMacMan is run, it loads the file MMIndex into a list of type *table*:

```
table : array [1. .MaxRec] of ptr1;
```

where *ptr1* is a pointer to a record similar to those stored in MMIndex and *MaxRec* is the number of functions or procedures in Manual. *MaxRec* is set by including the file MMSize.int.

Installing DAMacMan

DAMacMan is compiled into the resource file MacManFile. The Font/DA Mover utility tool is used to copy this file into a system file. After the DA has been installed in the system file of the start-up volume, it can be selected from the Apple menu.

Availability

All the source code for articles in this issue is available on a single disk. To order, send $14.95 to *Dr. Dobb's Journal*, 501 Galveston Dr., Redwood City, CA 94063, or call (415) 366-3600, ext. 216. Please specify the issue number and format (MS-DOS, MACINTOSH, KAYPRO).

The complete source code and binary files for DAMacMan are also available on Macintosh disk (single-sided) from the authors.

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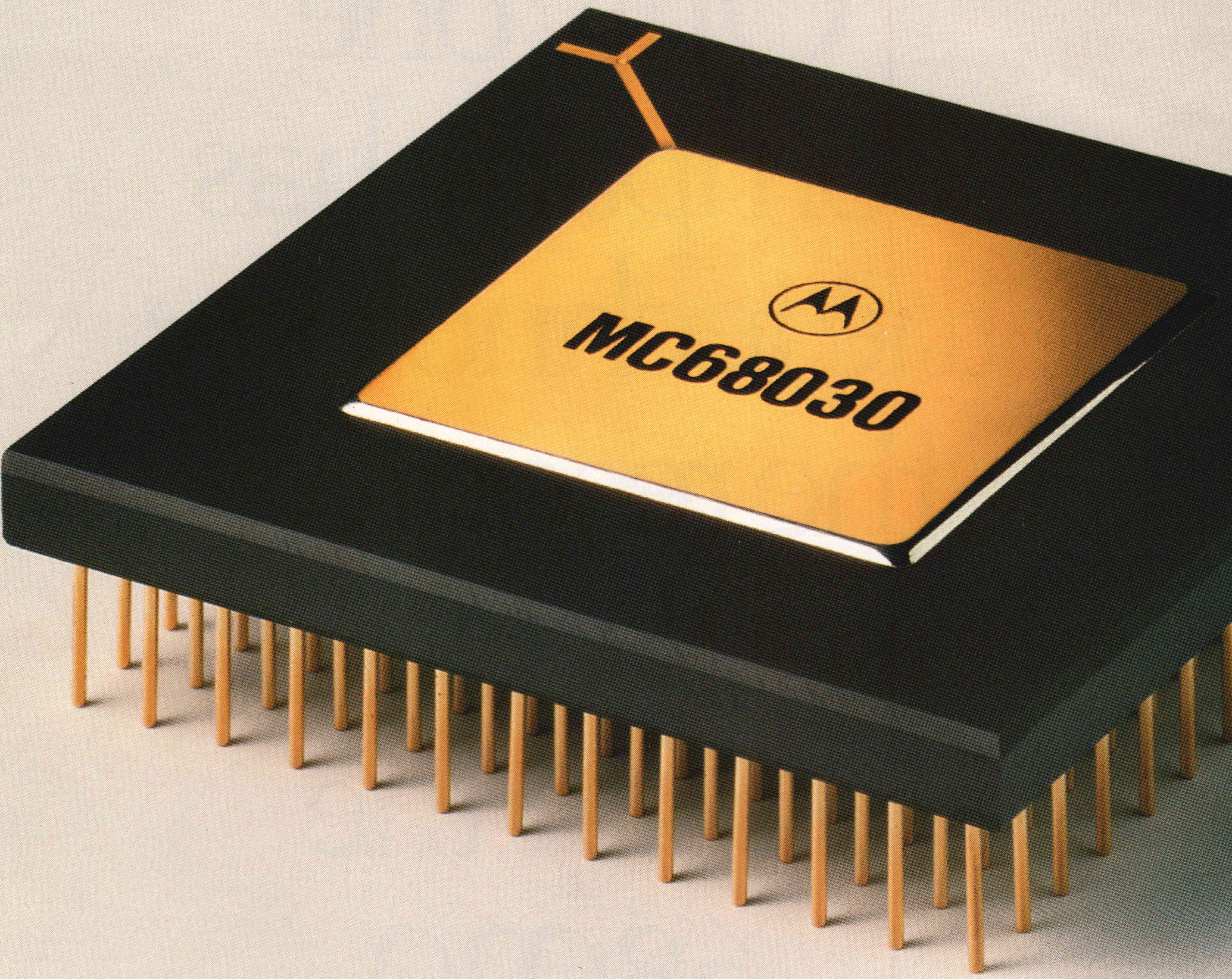

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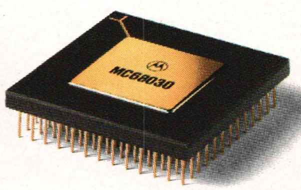

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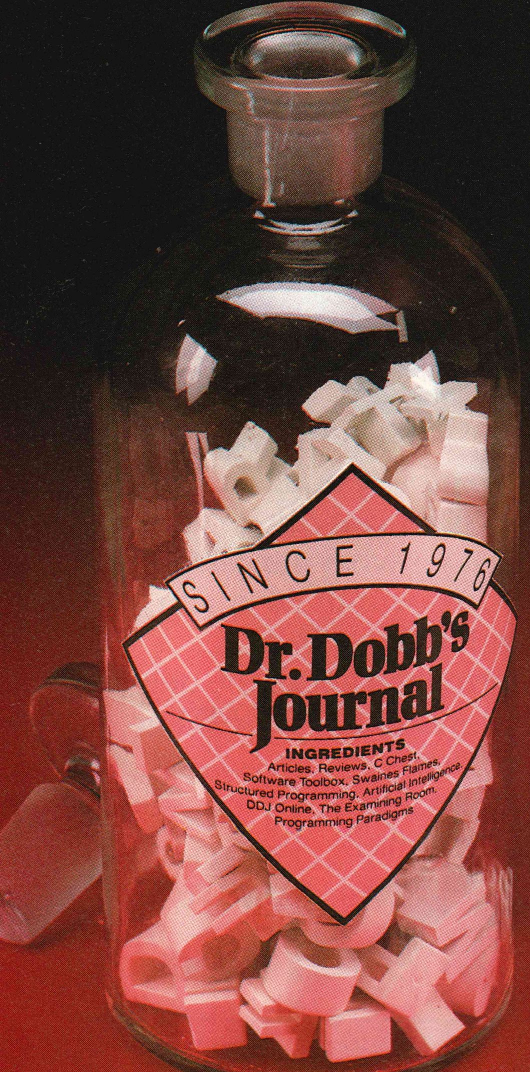

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(Listings begin on page 48.)

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```
PROGRAM  DAMacMan;
{ DAMacMan is an online inside macintosh, running as a desk accessory

  Pascal source:     DAMacMan.pas     Main Program
  Uses    :

            MMSize.Int       The Manual Size, Generated
                                              by MMConfig Tool
            DAMacMan.int   The Interface include file
            DAOthers.imp     Our own procedures and functions
            DAThree.imp       The open, Ctl, Close procedures
            DAIndex          Index To Database Entries
         Manual              Database from Inside Macintosh
  Resources  :       DAMacMan.R

  Creation Date:  July 1St, 1986
  Author      :          Abdullah  Al-Dhelaan
                       (TGL Software Development Group )
                      Oregon State University
}
{ The next four include files below are Interface to Toolbox ...}
{$I MemTypes.ipas    }
{$I QuickDraw.ipas    }
{$I OSIntf.ipas           }
{$I ToolIntf.ipas        }

{$I MMSize.Int          }     {The Manual Size, Generated
                                              by MMConfig Tool }
{$I DAMacMan.int      }    { The Interface include file    }
{$I DAOthers.imp        }    { Our own procedures and functions }
{$I DAThree.imp         }    {The open, Ctl, Close procedures }

{--------------------------Main Program---------------------------}
BEGIN
        { Desk Accessory,  There should be no main program }
END.
```

Example 6: *The DAMacMan main program*

Listing Twelve *(Text in December.)*

EXTERNS.H

```
/*
   This include file contains all of the external symbol definitions
   for modules that refer to external data.
*/

#ifndef  GLOBALS

extern   unsigned int   load_segment ;
extern   SEG_DESCRIPTOR *seg_list ;

extern   char   config_fname[FILENAME], abs_fname[FILENAME] ;
extern   char   module_name[FILENAME], locate_fname[FILENAME] ;
extern   char   print_fname[FILENAME], exe_fname[FILENAME] ;
extern   char   map_fname[FILENAME], tmp_fname[FILENAME] ;

extern   char   command_line[COMMAND_LINE] ;

extern   int    tmp_file ;
extern   int    abs_file ;
extern   int    exe_file ;

extern   FILE   *map_file ;
extern   FILE   *print_file ;
extern   FILE   *config_file ;

extern   BOOLEAN  boot_rec, help, config, user_abort, hex_name ;


#endif
```

End Listing Twelve

Listing Thirteen

GLOBALS.H

```
/*
   This module contains all of the global data declarations
*/

#ifndef  GLOBALS

unsigned int   load_segment ;
SEG_DESCRIPTOR *seg_list ;

char   config_fname[FILENAME], abs_fname[FILENAME] ;
char   module_name[FILENAME], locate_fname[FILENAME] ;
char   print_fname[FILENAME], exe_fname[FILENAME] ;
char   map_fname[FILENAME], tmp_fname[FILENAME] ;

char   command_line[COMMAND_LINE] ;

int    tmp_file ;
int    abs_file ;
int    exe_file ;

FILE   *map_file ;
FILE   *print_file ;
FILE   *config_file ;

BOOLEAN  boot_rec = FALSE, help = FALSE, config = FALSE ;
BOOLEAN  hex_name = FALSE, user_abort = FALSE ;

#define  GLOBALS

#endif
```

End Listing Thirteen

Listing Fourteen

LOC.H

```
#define  MAX_TOKEN      80
#define  MAX_LINE       80
#define  FILENAME       80
#define  COMMAND_LINE   256

#define  PAGE_SIZE      512

#define  ERROR     0      /* Error condition exists */
#define  OK        1      /* No error(s) detected */

#define  T_EOL    -2      /* Reached the end of a line */
#define  T_ERROR  -1      /* Detected an error condition */
#define  T_OK      0      /* Everything fine */
#define  T_OCT     1      /* Octal format integer */
#define  T_DEC     2      /* Decimal format integer */
```

```
#define T_HEX     3       /* Hexidecimal format integer */
#define T_WORD    4       /* Symbol character string */
#define T_OP      5       /* Operator character string */

typedef enum  { FALSE = 0, TRUE }  BOOLEAN ;

#define low_byte(x)       ((x) & 0xff)
#define high_byte(x)      (low_byte((x) >> 8))
#define dim(x)            (sizeof(x)/sizeof(x[0]))

typedef struct {
      unsigned int   signature ;
      unsigned int   length ;
      unsigned int   pages ;
      unsigned int   reloc_items ;
      unsigned int   header_size ;
      unsigned int   min_para ;
      unsigned int   max_para ;
      unsigned int   stack_seg_disp ;
      unsigned int   initial_sp ;
      unsigned int   checksum ;
      unsigned int   initial_pc ;
      unsigned int   code_seg_disp ;
      unsigned int   first_reloc_item ;
      unsigned int   overlay_num ;
   } EXE_HEADER ;


typedef struct sym_list  {
            struct sym_list *next ;
            char  name[32] ;
            unsigned int   value ;
            unsigned char  type ;
         } SYMBOL_LIST ;

typedef struct  seg_descriptor  {
            struct seg_descriptor    *next ;
            long  position ;
            char  name[32] ;
            char  class[32] ;
            unsigned int   vseg ;
            unsigned int   pseg ;
            unsigned int   offset ;
            unsigned int   len ;
            int   inited ;
            int   romable ;
            unsigned int   symbols ;
            SYMBOL_LIST *symbol_list ;
         } SEG_DESCRIPTOR ;

char  *load_exe_file() ;
SEG_DESCRIPTOR *build_seg_list() ;

int   get_ch() ;
int   unget_ch() ;
char  *get_cmd() ;
char  *get_line() ;

int get_token() ;

char  *get_mem(unsigned long) ;
void  free_mem(char *) ;

char  *process_command_line() ;
void  read_symbol_table(SEG_DESCRIPTOR *) ;

void  output_hex_OMF(int, SEG_DESCRIPTOR *, unsigned char *) ;
void  open_file_system() ;
void  close_file_system() ;
void  break_handler() ;

#define  DATA_RECORD     0
#define  EOF_RECORD      1
#define  ADDR_RECORD     2
#define  START_RECORD    3

void  write_START_record(int, unsigned char *) ;
void  write_ADDR_record(int, unsigned int ) ;
void  write_DATA_record(int, unsigned int, unsigned char *,
                                  unsigned int ) ;
void  write_EOF_record(int) ;
void  output_hex_record(int, unsigned char, unsigned int,
                                  unsigned char *, unsigned char) ;;
```

End Listing Fourteen

Listing Fifteen

```
          page    60, 132
          name    startup
          title   LOCATE Example ROM System Startup Code
          subttl  Turbo C 1.0 Version
```

(continued on next page)

Listing Fifteen *(Listing continued)*

```
;
;       ROM System Startup Code for Turbo C 1.0
;       Copyright (C) 1987 by Rick Naro.  All rights reserved.
;

;
;       Segment and group declarations
;

_text   segment byte    public  'CODE'
_text   ends
_etext  segment para    public  'CODEEND'
_etext  ends
_data   segment para    public  'DATA'
_data   ends
_bss    segment para    public  'BSS'
_bss    ends
_bssend segment byte    public  'BSSEND'
_bssend ends
_stack  segment para    stack   'STACK'
_stack  ends

dgroup  group   _data, _bss, _bssend

assume  cs:_text, ds:dgroup, ss:_stack

;
;       This version of the startup code expects 32-bit code pointers.
;       (medium or large memory models)
;

extrn   _main : far     ; Change to near for small/compact memory model

_text   segment

public  start

start   proc    far

        cli                             ; Disable interrupts

;
```

(continued on page 46)

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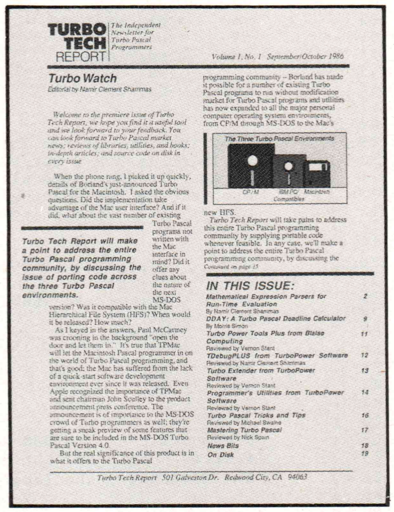

TURBO TECH REPORT | The Independent Newsletter for Turbo Pascal Programmers

Volume 1, No. 1 September/October 1986

Turbo Watch

Editorial by Namir Clement Shammas

Welcome to the premiere issue of Turbo Tech Report, we hope you find it a useful tool and we look forward to your feedback. You can look forward to Turbo Pascal market news; reviews of libraries, utilities, and books; in-depth articles; and source code on disk in every issue

When the phone rang, I picked it up quickly, details of Borland's just-announced Turbo Pascal for the Macintosh. I asked the obvious questions. Did the implementation take advantage of the Mac user interface? And if it did, what about the vast number of existing Turbo Pascal programs not written with the Mac interface in mind? Did it offer any clues about the nature of the next MS-DOS version? Was is compatible with the Mac Hierarchical File System (HFS)? When would it be released? How much?

As I keyed in the answers, Paul McCartney was crooning in the background "open the door and let them in." It's true that TPMac will let the Macintosh Pascal programmer in on the world of Turbo Pascal programming, and that's good; the Mac has suffered from the lack of a quick-start software development environment ever since it was released. Even Apple recognized the importance of TPMac and sent chairman John Sculley to the product announcement press conference. The announcement is of importance to the MS-DOS crowd of Turbo programmers as well; they're getting a sneak preview of some features that are sure to be included in the MS-DOS Turbo Pascal Version 4.0.

But the real significance of this product is in what it offers to the Turbo Pascal programming community – Borland has made it possible for a number of existing Turbo Pascal programs to run without modification market for Turbo Pascal programs and utilities has now expanded to all the major personal computer operating system environments, from CP/M through MS-DOS to the Mac's new HFS.

Turbo Tech Report will make a point to address the entire Turbo Pascal programming community, by discussing the issue of porting code across the three Turbo Pascal environments.

The Three Turbo Pascal Environments

CP/M | IBM PC/Compatibles | Macintosh

Turbo Tech Report will take pains to address this entire Turbo Pascal programming community by supplying portable code whenever feasible. In any case, we'll make a point to address the entire Turbo Pascal programming community, by discussing the

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Listing Fifteen *(Listing continued.)*

```
;       Initialize the stack segment and pointer
;

        mov     ax, _stack              ; Get the stack segment value
        mov     ss, ax                  ; Put in SS
        mov     sp, offset tos          ; Load the TOS in SP

;
;       Set up the segment registers for the initialization of DGROUP.
;       ES is initialized to DGROUP and DS is initialized to the copy of
;       DGROUP in ROM.
;

        mov     ax, dgroup              ; Get the segment for DGROUP
        mov     es, ax                  ; Install in ES

        mov     ax, _etext              ; Get the _etext segment
        inc     ax                      ; Adjust for the size of _etext
        mov     ds, ax                  ; Install in DS

;
;       Copy the copy of the initialized data segment _DATA from its
;       position in ROM (just after the CODE class) to the real _DATA
;       segment in RAM.  The size of the _DATA segment is computed by
;       subtracting the start of _DATA (the label idata) from the start
;       of the next segment (the label bdata).
;

        mov     si, offset DGROUP:idata ; Starting offset of _DATA
        mov     di, si                  ; Same offset, different segment
        mov     cx, offset DGROUP:bdata ; Get the end offset
        sub     cx, di                  ; Subtract the two for a length
        rep     movsb                   ; Copy initialized data

        push    es                      ; Get the value of DGROUP
        pop     ds                      ; Now it is in DS

;
;       C expects that the BSS segment is cleared when the program is
;       started.  Zero out the BSS segment within DGROUP by computing
;       the size using the label bdata and edata labels
;

        xor     al, al                  ; Use a zero fill pattern
        mov     di, offset DGROUP:bdata ; Get the starting offset
        mov     cx, offset DGROUP:edata ; Get the ending offset
        sub     cx, di                  ; Subtract the two for a length
        rep     stosb                   ; Zero out the BSS

;
;       Call main and hopefully never return ...
;

        sti                             ; Re-enable interrupts
        call    _main                   ; Call main()

;
;       Handle a return by restarting the entire process
;

        jmp     start                   ; Start all over

start   endp

_text   ends

        page
_etext  segment
public  tend
        db      16 dup (?)              ; Force alignment of the label
                                        ; tend with the next paragraph
tend    label   byte                    ; Mark the end of the segment
                                        ; Do NOT change this segment
_etext  ends

_data   segment
public  idata
idata   label   byte                    ; Start of the _DATA segment
_data   ends

_bss    segment
public  bdata
bdata   label   byte                    ; Start of the _BSS (and the
                                        ; end of the _DATA segment
_bss    ends

_bssend segment
public  edata
edata   label   byte                    ; Mark the end of the BSS
_bssend ends

_stack  segment
public  tos                             ; Make the TOS public
        dw      256 dup (?)             ; Declare the stack size
tos     label   byte                    ; Define the top of stack
_stack  ends

        end     start
```

End Listings

Listing One *(Text begins on page 24.)*

```
*           DAMacMan.r                    Resource
*           July 3, 1986                  Last modified
*
* Resource file for "DAMacMan.pas" for use with MacLanguage
* series Pascal Compiler (TML Pascal)
*
*
* all resources must be between -15872 and -15841 inclusive
* if they are to travel  with DRVR number 16

MacManFile
DFILDMOV

TYPE DRVR = PROC
  MacMan,16
DAMacMan

* this DLOG is the main window.
* the StatText items are used only for their rectangles.

Type WIND
  ,-15872
Untitled
50 40 300 510
InVisible GoAway
0
0

* menu used by the DA

type MENU
  ,-15872
Macman        ;; menu title
about Macman
(-
Find By Name
View By Category

* This second dialog is for about menu item
* the button and icon do nothing. Just decoration

Type ALRT
  ,-15872
50 50 330 430
-15872
4444

  ,-15871
50 50 300 480
-15871
4444

  ,-15870
60 80 126 430
-15870
4444
```

End Listing One

Listing Two

```
{
            DAMacMan.int                    Interface
            July 3, 1986                        Last modified

   An interface file that Contains all the needed types and vars

}

Const

  accEvent   = 64;
  accRun       = 65;
  accCursor = 66;
  accMenu    = 67;
  accUndo        = 68;
  accCut       = 70;
  accCopy     = 71;
  accPaste    = 72;
  accClear    = 73;

  ManFile      = 'Manual';     {Name of Database File}
  Vnum         = 0;  {default drive}

 Type
    Str25   = String [25];
    Lptr     = ^LongInt;
    Item    =  Record                            { An entity record}
                name        : Str25;                { Proc/Func. Name }
                   start             : LongInt;          { Starting pos. on the Manual }
               length        : Integer;            { Length of Proc./Func. Text }
               man           : Integer;            { Category # }
           END;
```

```
      ptrl   =   ^ Item;
      myarray   = ARRAY [1..MaxRec] of Ptrl;  { The main array }

  {This is the data. A handle to it will be stored in the dctl storage field
    of the DCltEntry Record  }

    GlobalsH = ^GlobalsP;
    GlobalsP = ^GlobalsRec;
    GlobalsRec = Record { DAMacMan Database Info }
                           hScroll    : ControlHandle;
                                                     {Horizontal scroll for window.}
                           vScroll    : ControlHandle;{Vertical scroll for window}
                           pRect      : Rect;        {Rectangle within window to see}
                        tRect      : Rect;
                        hTE         : TEHandle;      {Text is here...}
                           table      : myarray;     {Index to entries}
                    noIndex    : boolean;            {Error if no Index on Disk}
                       noman      : boolean;         {Error if no Database on Disk}
                      END;

  { This is used to store system info about the state of the driver. It will
    be passed to us on all calls from system. This Record is definded in the
    interface (TML files) above (as DCtlEntry) . it is not strictly necessary to
    redefine it here. But doing so,  will enable me to use dctlStorage^^ to
    refer to GlobalsRec without coercing Types }

    MyDeviceEntry = Record
                DctlDriver   : HAndle;     { Pointer to driver }
                DctlFlags     : Integer;  { Flags }
                DctlQueue   : Integer;   { Low-order byte, drivers version number }
                DctlQhead   : Lptr;          { Pointer to first entry in drivers I/O queue }
                DctlQTail      : Lptr;         { pointer to last entry in drivers I/O queue }
                DctlPosition: LongInt;  { Byte position }
                DctlStorage : GlobalsH; { Handle to RAM driver's private storage }
                DctlRefNum : Integer;  { Driver's reference number }
                DctlCurTicks: LongInt;  { Used internally by Device Manager }
                DctlWindow : Grafptr;  { Pointer to driver's window Record }
                DctlDelay      : Integer;  { number of ticks between periodic actions }
                DctlEmask   : Integer;   { Desk accessory event mask }
            DctlMenu      : Integer;   { Menu ID of menu associated with driver }
             END;

  { No VARiables for main program are allowed }
```

End Listing Two

(Listing Three begins on next page)

Listing Three *(Listing continued, text begins on page 24.)*

```
{
          DAThree.imp                  Implementatioon
          July 3, 1986                  Last modified

      THE FOLLOWING PROCEDURES SHOULD BE IN EVERY DESK ACCESSORY
      AND THEY ARE CALLED BY THE SYSTEM

}


 PROCEDURE open    ( VAR Device : MyDeviceEntry;
                       VAR block   :  ParamblockRec);
 { Open Makes a window and sets-up our private storage.
   we may get an open call even after we are already open }

CONST
        InfoLength = 700;   {The number of chars. fro the distribution text}
   VAR
     Wpk        : WindowPeek;
     Dtyp       : Integer;
     ID           : Integer;
     Dhan       : Handle;
     tmpPtr   : ptr;
     dummy    : GlobalsRec;
     Watch      : CursHandle;   {Handle to wristwatch cursor}

   BEGIN

   {Use ID for all Resource access}
   ID := $C000 - 32 * (1 + Device.dctlRefNum);
   Device.dctlMenu := ID;
    With Device do
    if DctlWindow = nil
   THEN BEGIN
      { Create a hole in the heap.  It is good practice to keep
           Window records off of the bottom of the Application Heap. }
        DctlStorage := pointer(NewHandle(SizeOf(dummy)));
        TmpPtr := NewPtr($1000);
        Hlock(Handle(DctlStorage));
        With DctlStorage^^ do
         BEGIN {initialize our storage }
```

```
          noindex := false;  {Index found}
             noman    := false;   {Manual found}
             Watch := GetCursor (WatchCursor);
             SetCursor (Watch^^);                     {Indicate delay }
           CreateWindow (Device,ID);
            { post information }
          DoOpen (Device,'MacMan Distribution',0,InfoLength);
              If not noman
              Then LoadData(device); {Load the array}
          initcursor;
      END;  { of with storage }
         {Deallocate our temporary pointer }
      Hunlock(Handle(DctlStorage));
       DisposPtr(TmpPtr);
    END; { of if }
 END; { of open }

{----------------------------------------------------------------------}

PROCEDURE close   (   VAR Device : MyDeviceEntry;
                         VAR block    : paramBlockRec);
 BEGIN
    deactivate(Device);       { remove menu }
    with Device do
    BEGIN
      disposHandle(Handle(DctlStorage));        { kill data }
      disposeWindow(DctlWindow);                 { erase window }
       DctlWindow := nil;
   END; {of with }
 END; { of close }

{----------------------------------------------------------------------}

 PROCEDURE ctl (      VAR Device : MyDeviceEntry;
                      VAR block : ParamBlockRec) ;
{ Here is the main entry point for system calls. The permanent bolck tell us
  what the nature of the call is. }
  VAR
       mousept      : point;
       wpnt         : Grafptr;
       item         : Integer;
       ibeam        : cursHandle;
       ignore       : Integer;
       longignore   : LongInt;
```

(continued on next page)

Listing Three *(Listing continued, text begins on page 24.)*

```
      BEGIN
         setport(Device.DctlWindow);
         Hlock(Handle(Device.DctlStorage));
         with Device, DctlStorage^^,block do
          BEGIN
             TEidle(hTE);
             CASE csCode of
                 accevent    :  Event(Device, block);
                 accCursor :
                   BEGIN
                      ibeam := GetCursor(ibeamcursor);
                      GetMouse(mousePt);
                      If (PtInRect(mousePt,pRect))
                        THEN SetCursor(iBeam^^)
                        ELSE InitCursor;
                   END;
                accmenu    :     { CASE out menu item number }
                  BEGIN
                     Initcursor;
                     CASE csParam[1] of
                             1 : Doabout (Device.dctlmenu);    {about... }
                            3 : IF (not noindex) THEN  DoFind  (Device,'');
                            4 : IF (not noindex) THEN  DoView  (Device)   ;
                        END; { of CASE menu }
                     HiliteMenu(0);
                 END; { of menu CASE }
              accCopy :
                BEGIN
                         longignore := ZeroScrap;  {Init. Scrap}
                  TECopy(hTE);            {Copy text from hte to TextEdit scrap}
                  ignore := TEToScrap;  {Copy  TextEdit scrap to desk scrap }
                  ignore := UnloadScrap; {Copy desk scrap to file scrap}
               END;
            Otherwise ;
          END; { CASE of ... }
         END; { of with block }
       Hunlock(Handle(Device.DctlStorage));
      END; { of control  PROCEDURE }
```

End Listings

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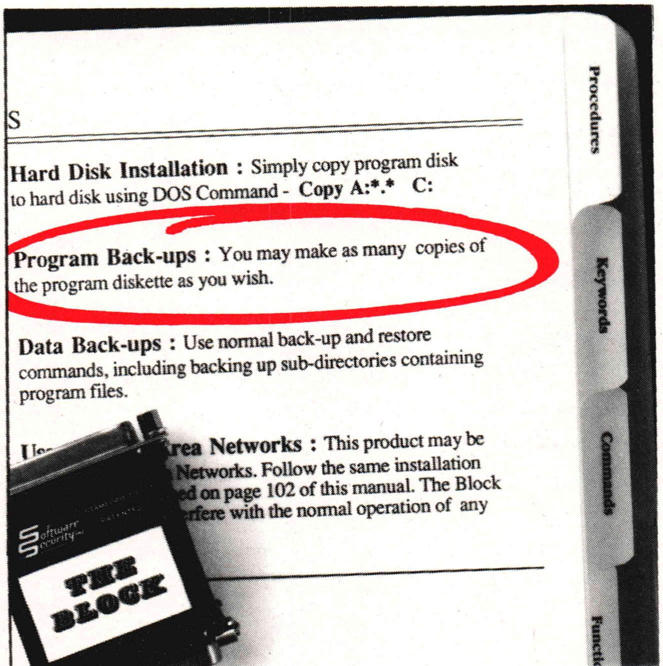

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203 329 8870

Listing One *(Text begins on page 90.)*

```
/*------------------------------ file information ----------------------------*/



/*
       custom controls demo.c

              c source code file for a minimal Mac program that demonstrates
                     controls drawn with a custom CDEF resource

              the custom CDEF resource that's demonstrated provides 16 button
variations
              the buttons …
                            ° … live in a rectangular space
                            ° … can be outlined, shadowed, or bare
                            ° … can contain text in any font-style-size, an icon, or
a picture
                            ° … can indicate highlighting via inversion or a change
of content

       edited and compiled with Lightspeed C 2.13

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holder.

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       spacestamp:           18617 Camp Creek Road       Hornbrook, California
96044

       this file looks good in 9 point Courier, LSC tabs set to 3
*/

/*--------------------------------- include files -----------------------------*/

/* definitions for Mac OS managers used herein */
#include       "ControlMgr.h"
#include       "DialogMgr.h"
#include       "EventMgr.h"
#include       "FontMgr.h"
#include       "MenuMgr.h"
#include       "Quickdraw.h"
#include       "StdFilePkg.h"

/* our stuff */
#include       "custom controls demo.h"           /*   private definitions for this
file  */


/*----------------------------- main program block ----------------------------*/

void    main()

              {
              /* local variable */
              int            theItem ;

              /* initialize Mac OS managers  */
              initializeManagers() ;

              /* see what the world is like */
              studyAndSetEnvironment () ;

              /* set up and draw a (dummy) title menu */
              InsertMenu( GetMenu(titleMenuID), append ) ;
              DrawMenuBar() ;

              /* set up and draw a modal dialog window */
              getThatDialogCookin () ;

              /* initalize our doneness indicator */
              finished = false ;

              /*  run the main event loop    */
              do

                     {
                     ModalDialog (noFilterProcedure, &theItem) ;
                     dealWithDialogItem (theItem) ;
                     }
              while

                     ( ! finished ) ;

              /*  leave neatly when done */
              DisposDialog (ourDialog) ;                /* bye bye to dialog */
              ExitToShell() ;                                  /* bye bye to
program */
              }

/*--------------------------- initializeManagers -----------------------------*/

/*   initialize the heap, cursor, and Mac Operating System managers     */
```

(continued on page 57)

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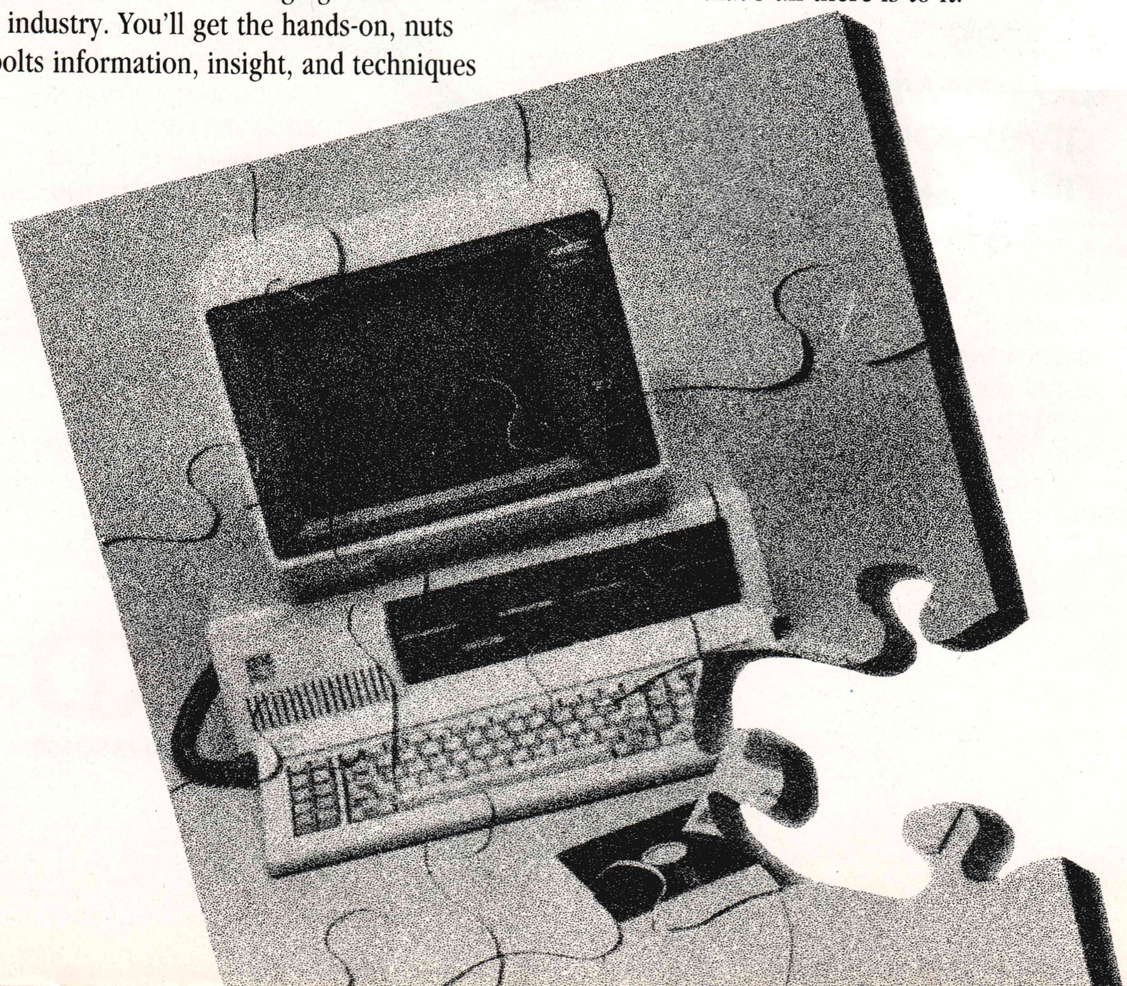

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Listing One *(Listing continued, text begins on page 90.)*

```
void    initializeManagers()

            {
            /* local variable */
            Handle          someDay ;

            /* get some space */
            MoreMasters() ;
            /* get some master pointers */
            if (someDay = NewHandle(humungousBlock))    /* grow a maximal heap by */
                   DisposHandle (someDay) ;             /* asking for the future */
                                                        /* get those managers going */

            InitGraf(&thePort) ;                        /* set up  Quickdraw */

            InitFonts();                                /* set  up the Font Manager */

            InitWindows();
            /* set up the Window Manager */
            InitMenus();                                /* set  up the Menu Manager */

            TEInit();
            /* set up Text Edit */
            InitDialogs (noResumeProcedure) ;           /* set up the Dialog Manager */

            /* final adjustments */
            FlushEvents (everyEvent, dontStop ) ;       /* clear the event queue */
            InitCursor();
            /* turn the cursor on */
            }

/*---------------------------- studyAndSetEnvironment -------------------------*/

/*   check out screens, machines, ROMs, et al */

void    studyAndSetEnvironment ()

            {
            /* check out the screen */
            screenRect = screenBits.bounds ;
            screenHeight = screenRect.bottom - screenRect.top ;
            screenWidth = screenRect.right - screenRect.left ;

            /* determine height of the menu bar */
            if      ( ROM85 & 0x8000 )
                   menuBarHeight = stdMBarHeight ;      /* for 64K ROMs        */
            else
                   menuBarHeight = MBarHeight ;         /* for newer  ROMs     */

            }


/*-------------------------------- getThatDialogCookin -------------------------*/

/* set up and draw our main modal dialog window */

void    getThatDialogCookin ()

            {
            /* local variables */
            Point                           tempPoint ;
            Rect                            scratch ;
            ControlHandle  theButton ;

            /* get the dialog window */
            ourDialog = GetNewDialog (ourDialogID, storeInHeap, inFront) ;

            /* adjust its position  */
            MoveWindow ( ourDialog,
                       (tempPoint = figureCenteredRectTLC  (&(*ourDialog).portRect)).h,
                        tempPoint.v, inFront ) ;


            /* make dialog window the current grafPort so we can change its font */
            SetPort (ourDialog) ;

            /* change its font to Geneva 12 */
            TextFont (geneva) ;
            TextSize (12) ;

            /* show the dialog */
            ShowWindow (ourDialog ) ;
            }


/*-------------------------------- dealWithDialogItem -------------------------*/

 /* deal with the hit item */

void    dealWithDialogItem (theItem)
            int             theItem ;

            {
```

(continued on next page)

TO THE MACS

Listing One
(Listing continued, text begins on page 90.)

```
/* local constants */
#define              oolSize                 6

/* local variables */
static short  onOffList[oolSize] = {        orwellItem, hupCoupleItem,

              ronItem, saveAsItem,

              pinheadItem, duplicateItem} ;
/* case out on the item */
switch (theItem)
       {
       case quitItem:
              finished = true ;
              break ;
       case orwellItem:
              doOrwellItem () ;
              break ;
       case snapshotItem:
              doSnapshotItem () ;
              break ;
       case mushroomItem:
              doMushroomItem () ;
              break ;
       case openItem:
              doOpenItem () ;
              break ;
       case saveAsItem:
              doSaveAsItem () ;
              break ;
       case flipItem:
              doFlipItem () ;
              break ;
       case someOffItem:
              doSomeOffItem (onOffList, oolSize) ;
              break ;
       case someOnItem:
              doSomeOnItem (onOffList, oolSize) ;
              break ;
       case copyrightItem:
              doCopyrightItem () ;
              break ;
       default:
```

```
                        break ;
                }

            /* remove local constants */
            #undef        oolSize
            }


/*--------------------------------- doOrwellItem -----------------------------*/

/* deal with a click of the orwellItem  button */

void   doOrwellItem ()

            {
            /* local constants */
            #define                     cyclesDesired        4
            #define                     delayTicksOne        20
            #define                     delayTicksTwo        10

            /* local variables */
            Rect                        scratch ;
            ControlHandle  theItemHandle ;
            short                       cycleCounter ;
            ControlHandle  ronItemHandle ;

            /* get a handle to the button */
            GetDItem ( ourDialog, orwellItem, &scratch, &theItemHandle, &scratch) ;

            /* hilite the button */
            HiliteControl (theItemHandle, hilitedHS ) ;

            /* get a handle to the ronItem button */
            GetDItem ( ourDialog, ronItem, &scratch, &ronItemHandle, &scratch) ;

            /* run several fade cycles on the ronItem button  */
            for ( cycleCounter = 0; cycleCounter < cyclesDesired; cycleCounter++)
                  {
                  /* fade out */
                  HiliteControl (ronItemHandle, inactiveHS ) ;

                  /* wait a while */
                  Delay (delayTicksOne, &scratch) ;

                  /* back into view */
                  HiliteControl (ronItemHandle, activeHS ) ;
```

(continued on next page)

Listing One *(Listing continued, text begins on page 90.)*

```
                /* wait a while */
                Delay (delayTicksTwo, &scratch) ;
                }

        /* unhilite the button */
        HiliteControl (theItemHandle, activeHS ) ;

        /* remove local constants */
        #undef          cyclesDesired
        #undef          delayTicksOne
        #undef          delayTicksTwo
        }

/*--------------------------------- doSnapshotItem ----------------------------*/

/* deal with a click of the snapshotItem button */

void    doSnapshotItem ()

        {
        /* local variables */
        ControlHandle theItemHandle ;
        Rect                            scratch ;
        GrafPtr                         entryGrafPort ;

        /* get a handle to the button */
        GetDItem ( ourDialog, snapshotItem, &scratch, &theItemHandle, &scratch)
;

        /* hilite the button */
        HiliteControl (theItemHandle, hilitedHS ) ;

        /* save a pointer to the grafPort */
        GetPort(&entryGrafPort) ;

        /* this lets me take some snapshots */
        /* has no effect unless you have a desk accessory named Camera */

        OpenDeskAcc ("\007\000Camera") ;

        /* restore the grafPort */
        SetPort(entryGrafPort) ;

        /* unhilite the button */
        HiliteControl (theItemHandle, activeHS ) ;
        }

/*--------------------------------- doMushroomItem ----------------------------*/

/* deal with a click of the mushroomItem  button */

void    doMushroomItem ()

        {
        /* local constants */
        #define                         cyclesDesired           4
        #define                         delayTicks                      30

        /* local variables */
        Rect                            scratch ;
        short                           cycleCounter ;
        ControlHandle  itemHandleOne ;
        ControlHandle  itemHandleTwo ;

        /* get a handle to the button */
        GetDItem ( ourDialog, mushroomItem, &scratch, &itemHandleOne, &scratch)
;

        /* hilite the button */
        HiliteControl (itemHandleOne, hilitedHS ) ;

        /* get a handle to the bumperStickersItem button */
        GetDItem ( ourDialog, bumperStickersItem, &scratch,
                                        &itemHandleTwo, &scratch) ;

        /* run several fade cycles on the bumperStickersItem button  */
        for ( cycleCounter = 0; cycleCounter < cyclesDesired; cycleCounter++)
                {
                /* fade out */
                HiliteControl (itemHandleTwo, hilitedHS ) ;

                /* wait a while */
                Delay (delayTicks, &scratch) ;

                /* back into view */
                HiliteControl (itemHandleTwo, activeHS ) ;

                /* wait a while */
                Delay (delayTicks, &scratch) ;
                }

        /* unhilite the button */
        HiliteControl (itemHandleOne, activeHS ) ;
```

```
        /* remove local constants */
#undef          cyclesDesired
#undef          delayTicks
        }

/*---------------------------------- doOpenItem ------------------------------*/

/* deal with a click of the openItem button */

void    doOpenItem ()

        {
        /* local variables */
        Rect                        scratch ;
        ControlHandle  theItemHandle ;
        DialogTHndl          theDLOGHandle ;
        SFReply                     dummyReply ;

        /* get a handle to the button */
        GetDItem ( ourDialog, openItem, &scratch, &theItemHandle, &scratch) ;

        /* hilite the button */
        HiliteControl (theItemHandle, hilitedHS ) ;

        /* run the standard file open dialog */
        theDLOGHandle = (DialogTHndl) GetResource ('DLOG', getDlgID) ;
        SFGetFile (figureCenteredRectTLC (&(**theDLOGHandle).boundsRect),
                                    nil, nil, allTypes, nil, nil, &dummyReply ) ;


        /* unhilite the button */
        HiliteControl (theItemHandle, activeHS ) ;
        }

/*-------------------------------- doSaveAsItem -------------------------------*/

/* deal with a click of the saveAsItem button */

void    doSaveAsItem ()

        {
        /* local variables */
        Rect                        scratch ;
        ControlHandle  theItemHandle ;
        DialogTHndl          theDLOGHandle ;
        SFReply                     dummyReply ;

        /* get a handle to the button */
        GetDItem ( ourDialog, saveAsItem, &scratch, &theItemHandle, &scratch) ;

        /* hilite the button */
        HiliteControl (theItemHandle, hilitedHS ) ;

        /* run the standard file open dialog */
        theDLOGHandle = (DialogTHndl) GetResource ('DLOG', putDlgID) ;
        SFPutFile (figureCenteredRectTLC (&(**theDLOGHandle).boundsRect),
                        "\015Save file as:", "\021Current File Name",
                          nil, &dummyReply ) ;


        /* unhilite the button */
        HiliteControl (theItemHandle, activeHS ) ;
        }

/*-------------------------------- doFlipItem --------------------------------*/

/* deal with a click of the flipItem button */

void    doFlipItem ()

        {
        /* local constants */
#define              numButtons          9
#define              cyclesDesired 4
#define              delayTicks          15

        /* local variables */
        static short  flipList [numButtons] =
                          {    hupCoupleItem,          mouthOpensItem,
                          trashItem,                   melancholyItem,
                          eeekShrinkItem,              mushroomItem,
                          duplicateItem,               orwellItem,
                          bumperStickersItem
        } ;
        Rect                        scratch ;
        ControlHandle  theItemHandle ;
        short                       cycleCounter ;
        short                       index ;
        ControlHandle  tempItemHandle ;
```

(continued on next page)

Listing One *(Listing continued, text begins on page 90.)*

```
                    /* get a handle to the button */
                    GetDItem ( ourDialog, flipItem, &scratch, &theItemHandle, &scratch) ;

                    /* hilite the button */
                    HiliteControl (theItemHandle, hilitedHS ) ;

                    /* run several animation cycles on a group of content-changing buttons
*/
                    for ( cycleCounter = 0; cycleCounter < cyclesDesired; cycleCounter++)
                              {
                              /* hilite all the buttons in the group  */
                              for (index = 0 ; index < numButtons ; index++)
                                        {
                                        GetDItem ( ourDialog, flipList[index], &scratch,
                                                            &tempItemHandle, &scratch) ;
                                        HiliteControl (tempItemHandle, hilitedHS ) ;
                                        }

                              /* wait a while */
                              Delay (delayTicks, &scratch) ;

                              /* unhilite all the buttons in the group */
                              for (index = 0 ; index < numButtons ; index++)
                                        {
                                        GetDItem ( ourDialog, flipList[index], &scratch,
                                                            &tempItemHandle, &scratch) ;
                                        HiliteControl (tempItemHandle, activeHS ) ;
                                        }

                              /* wait a while */
                              Delay (delayTicks, &scratch) ;
                              }

                    /* unhilite the button */
                    HiliteControl (theItemHandle, activeHS ) ;

                    /* remove local constants */
                    #undef          numButtons
                    #undef          cyclesDesired
                    #undef          delayTicks
                    }

/*------------------------------ doSomeOffItem ------------------------------*/

/* deal with a click of the someOffItem button  */

void    doSomeOffItem (theOffList, listSize)
                    short           theOffList[] ;
                    short           listSize ;

                    {
                    /* local variables */
                    short                           index ;
                    Rect                            scratch ;
                    ControlHandle  theItemHandle ;
                    ControlHandle  tempItemHandle ;

                    /* get a handle to the button  */
                    GetDItem ( ourDialog, someOffItem, &scratch, &theItemHandle, &scratch) ;

                    /* hilite the button */
                    HiliteControl (theItemHandle, hilitedHS ) ;

                    /* for each item in the list */
                    for (index = 0 ; index < listSize ; index++)
                              {
                              /* get a handle to the item */
                              GetDItem ( ourDialog, theOffList[index], &scratch,
                                                  &tempItemHandle, &scratch) ;

                              /* inactivate the item */
                              HiliteControl (tempItemHandle, inactiveHS ) ;
                              }

                    /* unhilite the someOffItem button  */
                    HiliteControl (theItemHandle, activeHS ) ;
                    }

/*------------------------------ doSomeOnItem ------------------------------*/

/* deal with a hit of the someOnItem button  */

void    doSomeOnItem (theOnList, listSize)
                    short           theOnList[] ;
                    short           listSize ;

                    {
                    /* local variables */
                    short                           index ;
                    Rect                            scratch ;
                    ControlHandle  theItemHandle ;
                    ControlHandle  tempItemHandle ;
```

```
                /* get a handle to the button  */
                GetDItem ( ourDialog, someOnItem, &scratch, &theItemHandle, &scratch) ;

                /* hilite the button */
                HiliteControl (theItemHandle, hilitedHS ) ;

                /* for each item in the list */

                for (index = 0 ; index < listSize ; index++)
                        {
                        /* get a handle to the item */
                        GetDItem ( ourDialog, theOnList[index], &scratch,
                                              &tempItemHandle, &scratch) ;

                        /* activate the item */
                        HiliteControl (tempItemHandle, activeHS ) ;
                        }

                /* unhilite the someOnItem button  */
                HiliteControl (theItemHandle, activeHS ) ;
                }

/*--------------------------------doCopyrightItem ----------------------------*/

/* deal with a hit on the copyrightItem button */

void    doCopyrightItem ()

                {
                /* local variables */
                Rect                            scratch ;
                ControlHandle  theItemHandle ;
                DialogPtr               copyrightDlog ;
                Point                           tempPoint ;

                /* get a handle to the button */
                GetDItem ( ourDialog, copyrightItem, &scratch, &theItemHandle, &scratch)
;

                /* hilite the button */
                HiliteControl (theItemHandle, hilitedHS ) ;

                /* pull in the copyright notice modal dialog */
                copyrightDlog = GetNewDialog (copyrightDlogID, storeInHeap, inFront) ;

                /* center it on the screen */
                MoveWindow ( copyrightDlog,
                             (tempPoint = figureCenteredRectTLC
(&(*copyrightDlog).portRect)).h,
                              tempPoint.v, inFront ) ;

                /* show the copyright notice */
                ShowWindow (copyrightDlog ) ;

                /* wait until the user clicks the mouse in the dialog */
                ModalDialog (noFilterProcedure, &scratch) ;

                /* get rid of the dialog */
                DisposDialog (copyrightDlog) ;

                /* unhilite the button */
                HiliteControl (theItemHandle, activeHS ) ;
                }

/*--------------------------- figureCenteredRectTLC ---------------------------*/

/* given a rectangle, returns the top left corner  position that will
       center the rectangle inside screen area that's below the menu bar */

Point   figureCenteredRectTLC (theRect)




                Rect    *theRect ;

                {
                 /* local variable */
                Point   theResult ;

                 /* figure the vertical position */
                 theResult.v = menuBarHeight + ((screenHeight - menuBarHeight) -
                                                                        (theRect-
>bottom - theRect->top) )  /  2 ;

                 /* figure the horizontal position */
                 theResult.h = ( screenWidth - (theRect->right - theRect->left) )   /
2 ;
```

(continued on next page)

Listing One *(Listing continued, text begins on page 90.)*

```
   /* done, so return the point */
   return (theResult) ;
  }
```

End Listing One

Listing Two

```
/*------------------------------ file information -----------------------------*/

/*
        custom controls demo.h

        private definitions for custom controls demo.c

        edited and compiled with Lightspeed C 2.13

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        timestamp:          5:56 pm PST                    November 16, 1987
        spacestamp:         18617 Camp Creek Road       Hornbrook, California 96044


        this file looks good in 9 point Courier, LSC tabs set to 3
*/


/*-------------------------------- constants ----------------------------------*/

/* booleans */
#define              true                         1
#define              false                        0

/* parameters */
#define              humungousBlock               0x8FFFFFFF
#define              noResumeProcedure            0
#define              dontStop                     0
#define              nil                          0
#define              allTypes                     -1

/* control stuff */
#define              activeHS                     0              /* three hilite states */
#define              inactiveHS                   255
#define              hilitedHS                    10


/* menu stuff */
#define              stdMBarHeight  20
#define              titleMenuID                  1
#define              append                       0

/* dialog stuff */
#define         storeInHeap                       0
#define              inFront                      -1
#define              ourDialogID                  1
#define              copyrightDlogID              210
#define              noFilterProcedure            0

#define              quitItem                     1
#define              orwellItem                   2
#define              snapshotItem                 3
#define              bumperStickersItem           4
#define              mushroomItem                 5

#define              hupCoupleItem                6
#define              openItem                     7
#define              ronItem                      8
#define              saveAsItem                   9
#define              duplicateItem                10

#define              woozyItem                    11
#define              trashItem                    12
#define              flipItem                     13
#define              mouthOpensItem               14
#define              copyItem                     15

#define              melancholyItem               16
#define              pinheadItem                  17
#define              someOffItem                  18
#define              someOnItem                   19
#define              eeekShrinkItem               20
```

```
#define              copyrightItem        21

/*-------------------------------- type definitions --------------------------*/

typedef              short  boolean;

/*--------------------------- function prototypes ----------------------------*/

void    main (void) ;
void    initializeManagers (void) ;
void    studyAndSetEnvironment (void) ;
void    getThatDialogCookin (void) ;
void    dealWithDialogItem (int   theItem) ;
void    doSnapshotItem (void) ;
void    doOrwellItem (void) ;
void    doMushroomItem (void) ;
void    doOpenItem (void) ;
void    doSaveAsItem (void) ;
void    doFlipItem (void) ;
void    doSomeOffItem (short  theOffList[], short   listSize);
void    doSomeOnItem (short  theOnList[], short   listSize);
void    doCopyrightItem (void) ;
Point   figureCenteredRectTLC (Rect    *theRect) ;

/*----------------------------- global variables ----------------------------*/

boolean                    finished ;               /* indicates when the
program should end */
DialogPtr            ourDialog ;              /* points to our main dialog */

int                        menuBarHeight ;      /* know your environment... */
int                        screenHeight ;
int                        screenWidth ;
Rect                       screenRect ;
```

End Listings

Listing One *(Listing continued,* *text begins on page 108.)*

```
Listing One.  Example for declaring various objects that are
              variations of stack structures
PROGRAM Test_Objects(input,output);

{ Simple example for objects using TML Pascal running on a Mac Plus }

TYPE RealStackReg = ARRAY [1..4] OF real;
     IntStackReg  = ARRAY [1..4] OF integer;

     { define common stack-related variables and routines }
     TStack = OBJECT
        height : integer;
        ErrorFlag : boolean;
        PROCEDURE TStack.IStack;
        PROCEDURE TStack.Inc(VAR i : integer);
        PROCEDURE TStack.Dec(VAR i : integer);
     END;

     { define a 4-register real-typed stack }
     TRealStack = OBJECT(TStack)
        Regs : RealStackReg;
        PROCEDURE Push(Item : real);
        FUNCTION Pop : real;
        PROCEDURE Add;
     END;

     { define a 4-register real-typed stack with automatic
     LastX register }
     THPStack = OBJECT(TRealStack)
        LastX : real;
        PROCEDURE Add; OVERRIDE;
     END;

     { define a 4-register integer-typed stack }
     TIntStack = OBJECT(TStack)
        Regs : IntStackReg;
        PROCEDURE Push(Item : integer);
        FUNCTION Pop : integer;
        PROCEDURE Add;
     END;


PROCEDURE TStack.IStack;
{ Initialize TStack objects by setting the Stack height to zero }
BEGIN
  height := 0
END; { Stack.IStack }
PROCEDURE TStack.Inc(VAR i : integer);

BEGIN
  i := i + 1;
END;

PROCEDURE TStack.Dec(VAR i : integer);

BEGIN
  i := i - 1;
END;


PROCEDURE TRealStack.Push(Item : real);

VAR i : integer;

BEGIN
   Inc(height);
   FOR i := 4 DOWNTO 2 DO
      Regs[i] := Regs[i-1];

   Regs[1] := Item;
END; { RealStack.Push }
FUNCTION TRealStack.Pop : real;

VAR i : integer;
BEGIN
   IF height > 0 THEN BEGIN
      Pop := Regs[1];
      FOR i := 1 TO 3 DO
```

```
        Regs[i] := Regs[i+1];
      Dec(height);
      ErrorFlag := FALSE;
    END
    ELSE BEGIN
      Pop := 1.0E+30;
      ErrorFlag := TRUE
    END;

END; { TRealStack.Pop }
PROCEDURE TRealStack.Add;

VAR i : integer;

BEGIN
  Regs[1] := Regs[1] + Regs[2];
  FOR i := 2 TO 3 DO
    Regs[i] := Regs[i+1];
END; { TRealStack.Add }

PROCEDURE THPStack.Add;

VAR i : integer;

BEGIN
  LastX := Regs[1];
  Regs[1] := Regs[1] + Regs[2];
  FOR i := 2 TO 3 DO
    Regs[i] := Regs[i+1];
END;{ THPStack.Add }

PROCEDURE TIntStack.Push(Item : integer);

VAR i : integer;

BEGIN
   Inc(height);
   FOR i := 4 DOWNTO 2 DO
      Regs[i] := Regs[i-1];

   Regs[1] := Item;
END; { TIntStack.Push }


FUNCTION TIntStack.Pop : integer;

VAR i : integer;

BEGIN
   IF height > 0 THEN BEGIN
      Pop := Regs[1];
      FOR i := 1 TO 3 DO
         Regs[i] := Regs[i+1];
      Dec(height);
      ErrorFlag := FALSE
   END
   ELSE BEGIN
     Pop := -32767;
     ErrorFlag := TRUE
   END;
END; { TIntStack.Pop }

PROCEDURE TIntStack.Add;

VAR i : integer;

BEGIN
  Regs[1] := Regs[1] + Regs[2];
  FOR i := 2 TO 3 DO
    Regs[i] := Regs[i+1];
END; { TIntStack.Add }

{ --------------- declarations of variables ------------------ }

VAR RealStack : TRealStack;
    IntStack : TIntStack;
    { HPStack : THPStack; }
    X : real;
    I : integer;
    ch : char;
```

(continued on next page)

Listing One *(Listing continued, text begins on page 108.)*

```
BEGIN
  NEW(RealStack);
  NEW(IntStack);
  NEW(HPStack);
  { exercise real-type stack }
  RealStack.IStack;
  RealStack.Push(1.0);
  RealStack.Push(2.0);
  RealStack.Push(3.0);
  RealStack.Push(4.0);
  RealStack.Add;
  X := RealStack.Pop;
  WRITELN('X = ',X); WRITELN;
  { use HPStack }
  HPStack.IStack;
  HPStack.Push(0.0);
  HPStack.Push(0.0);
  HPStack.Push(3.0);
  HPStack.Push(4.0);
  INHERITED HPStack.Add;
  X := HPStack.Pop;
  WRITELN('X = ',X);
  WRITELN('LastX = ',HPStack.LastX);
  WRITELN;
  { exercise integer-type stack }
  IntStack.IStack;
  IntStack.Push(1);
  IntStack.Push(2);
  IntStack.Push(3);
  IntStack.Push(4);
  IntStack.Add;
  I := IntStack.Pop;
  WRITELN('I = ',I); WRITELN;
  readln(ch);
END.
```

End Listing

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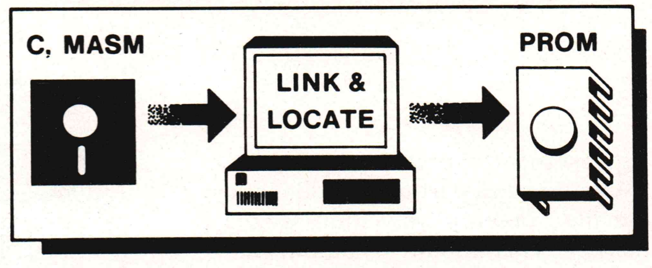

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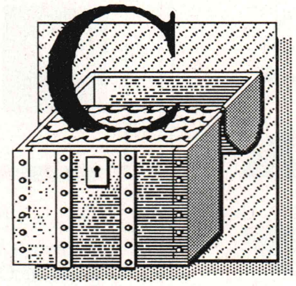

Last month I presented the users' guide and part of the code for a small, preemptive multitasking kernel. This month's column finishes up with the rest of the code and a description of how the subroutines work. The code appears in Listings One to Seven on pages 110–123 of the December 1987 issue.

I can only hope to give you a bare-bones introduction to operating system innards here. If you're starting out from scratch and want to pursue the matter further, I can recommend two excellent books. If you're interested in kernels only (which is often the case for ROM-based systems), Ted Biggerstaff's *System Software Tools* (Englewood Cliffs, N.J.: Prentice-Hall, 1986) presents both the underlying theory and the complete C source for a small multitasking kernel that runs on the IBM PC. Biggerstaff's OS includes a primitive screen I/O system, but hard stuff—such as the disk I/O—is relegated to DOS. Unlike my kernel, though, Biggerstaff's program lets you run other programs as subprocesses.

For a more in-depth introduction to operating systems in general, Andrew Tanenbaum's *Operating Systems: Design and Implementation* (Englewood Cliffs, N.J.: Prentice-Hall, 1987) is the best book on the subject that I've ever seen. It's both very complete in its coverage of the subject and extremely well written. (It's not often that a textbook is readable, but this book is a glowing exception

by Allen Holub

to the obfuscation-is-better rule.) Over the course of the book, Tanenbaum develops a complete Unix look-alike system, called MINIX, that runs on an IBM PC/XT or AT. He presents all the underlying theory in considerable depth as well as a complete implementation (in C) of the MINIX kernel. He covers virtually every aspect of operating system design, from the lowest-level disk driver (which interfaces directly to the hardware) up to the context-swapping code.

The book includes the full sources to the kernel, and if you spring for the accompanying disk (it's $80 from Prentice-Hall), you get an executable operating system and full sources for it and most of the other programs you need to actually use the operating system. (The disk contains a C compiler and an assembler, but you don't get the sources for these). The system provides something like 65 commands—the basic stuff such as cp, chmod, and so on and big stuff as well, such as a shell, an editor, grep, tar, uniq, roff, sort, pr, make, and ar. All these run under MINIX, of course, not DOS. But for $80 this is one of the deals of the century. Unlike Gnu, a public-domain Unix look-alike system, MINIX is not vaporware. In fact, the $80 you pay for MINIX is less than what you pay as a media fee when you get the "free" copy of Gnu.

Operating System Organization

As I mentioned last month, you can look at an interrupt-driven I/O system as an operating system. That is, each interrupt-service routine is a task, and the context swapping (changing from one task to another) is performed by the hardware every time an interrupt comes along. The task's priority is hard-wired into the hardware.

In most operating systems, however, context swaps are done in other ways: either a running task voluntarily yields (gives up control) to another task or a timer interrupt comes along and the running task is preempted (control is involuntarily taken from it). The part of the operating system that takes care of the swapping (and of figuring out which of several tasks should get control at any given moment) is called the kernel.

There are several ways to organize an operating system, two of which are shown in Figure 1, page 74. In the top diagram, the system is organized in onion-skin-like layers. Unix and MS-DOS are both examples of this organization. All I/O is done through the kernel, and access to the interrupts is done through the I/O system. The advantage of this approach is that it's easy to manage system resources—for example, you don't have to worry about two tasks both trying to write to the disk simultaneously; the kernel will act as a traffic cop.

The second diagram in Figure 1 shows how my own system is organized. This organization is mandated by the fact that I'm using DOS to do my I/O and that the kernel is part of the running program, not part of DOS itself. Resource management is a real problem in my system because DOS is not itself reentrant. It's up to the running task to assure that it cannot be preempted while it's performing a DOS call. You can do this in one of three ways.

The easiest method is to block all other tasks (the current task retains control of the CPU) using the *t_block()* and *t_release()* system calls. The problem here is that an I/O intensive task may use up an inordinate amount of system time.

An alternate approach is to use an exclusion semaphore. A semaphore is a length 1 message queue, created with a *t_makequeue()*

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system call. Normally a message is waiting at the queue. When a task wants a resource, it pends (waits for a message to arrive) at this queue by calling *t_wait( )*. When the task has finished with the resource, it posts the message back to the queue using *t_send( )*.

A third approach puts another level of isolation into the picture. Here, a special task is in charge of every resource. A second task sends a request to the resource task (again using the message mechanism), which performs an operation and then sends the result back to the calling task. For example, a single task might be in charge of all screen I/O. When a task wanted to send something to the screen, it would just post a message at the screen task's input queue (the message would probably be a pointer to a string) and the screen task would do the actual I/O. Another example is a disk I/O task. Here the requesting task would send a read-request message to the disk manager. This message would contain some sort of file descriptor, a count of the number of bytes to read, a pointer to a buffer, and the address of a queue to which the disk manager should send a response. The manager would fill the buffer and return a "done" message to the indicated return address when the disk access was complete.

The resource-manager approach is often the best for two reasons. First, messages can't possibly get intermingled because the screen task will process them in the order received. Second, the I/O process can be done in parallel with other tasks. For example, the disk manager could start up a DMA transfer and then suspend itself by waiting on a queue. The interrupt-service routine that's triggered by the DMA controller when the transfer is done posts a message to this same queue. In the interim, however, the disk manager is suspended, which means that other tasks can be active. Had you used the block/release strategy or an exclusion semaphore, all activity would stop while the active task waited for the transfer to complete. The kernel itself contains no resource managers, however. You'll have to write your own.

The Data Structures

So, what exactly is a task? Individual tasks (or processes) consist of several parts. First is the code itself. For reasons that will be apparent shortly, this code must be reentrant. That is, you must write it as if it were a recursive function—at least in terms of static-variable usage and so forth. If you're careful, several tasks can share the same code (because, like recursive subroutines, they all have unique stacks—more on this momentarily). The second part of a task is a task control block, or TCB. The TCB that's used by the kernel is defined in kernel.h (Listing One) starting on line 60. It's also shown in Example 1, page 78.

The TCB is shown graphically in Figure 2, below. The TCB structure forms a header, and the remainder of the structure is memory that will be used for a task's stack. The size of the stack is determined at task-create time (it's passed into *t_create( )* as an argument). TCBs (or pointers to them) are stored in one of three places: in an active list, which is a priority queue consisting of all tasks that have been preempted and are waiting to be activated; queued up at a message (I'll look at this process in a moment); or, if the task is the currently running task, a pointer to the task is held in the global variable *T_active*.

Several things happen when a timer interrupt comes along. First, the various message queues are examined, and if any of the tasks waiting at these queues have timed-out, they are added to the active list. Next, the priority of the running task is compared with the highest-priority task in the active list, and if the latter is higher, a context swap is

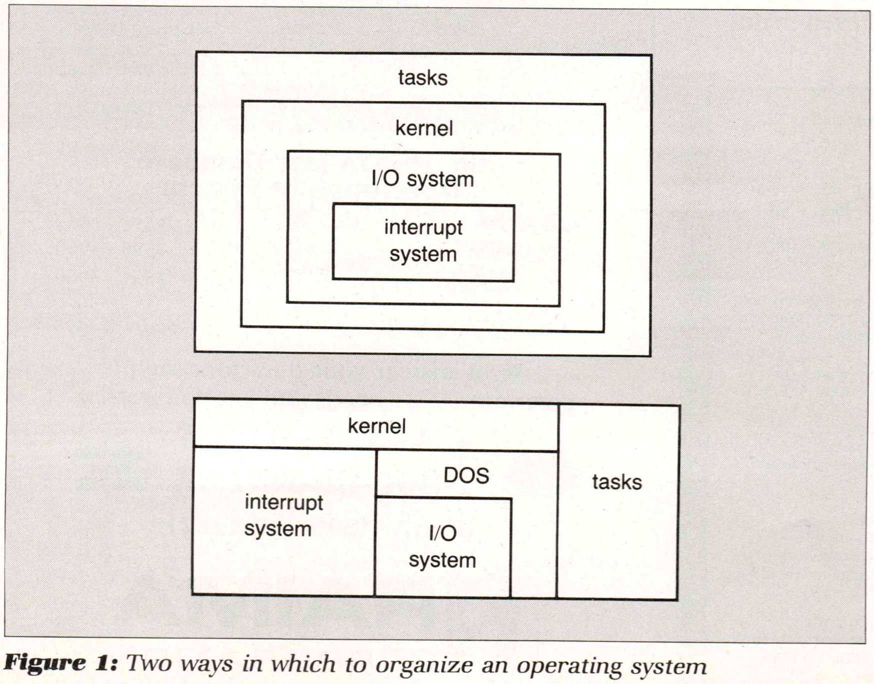

Figure 1: *Two ways in which to organize an operating system*

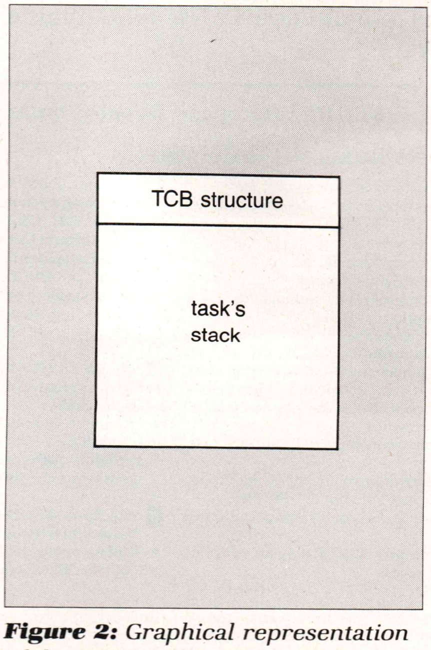

Figure 2: *Graphical representation of the TCB used by the kernel*

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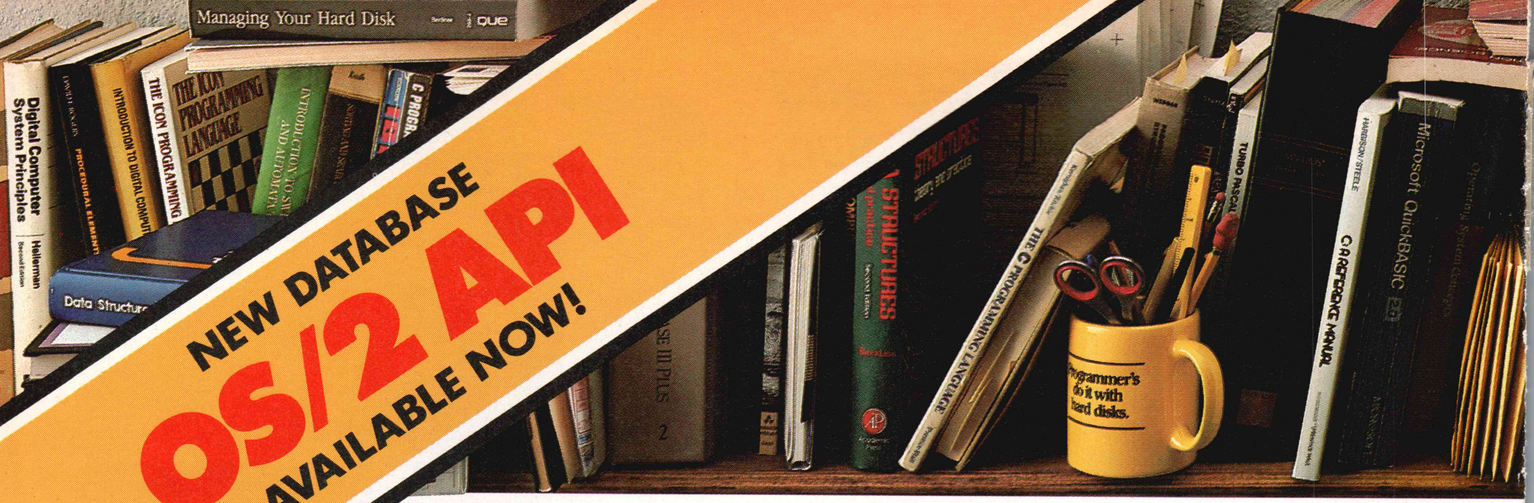

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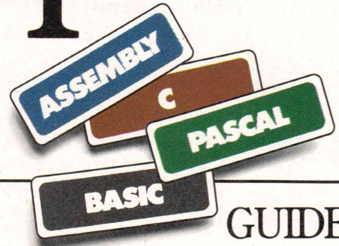

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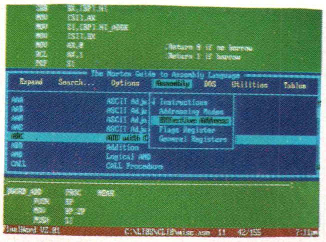

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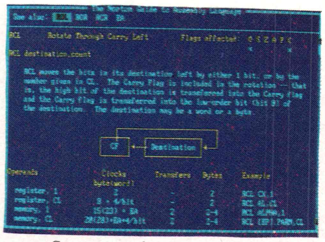

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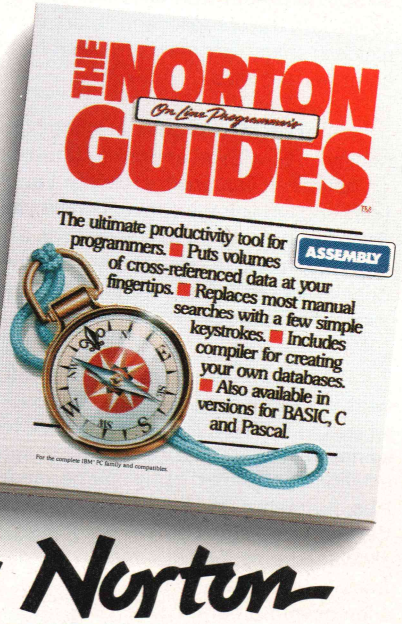

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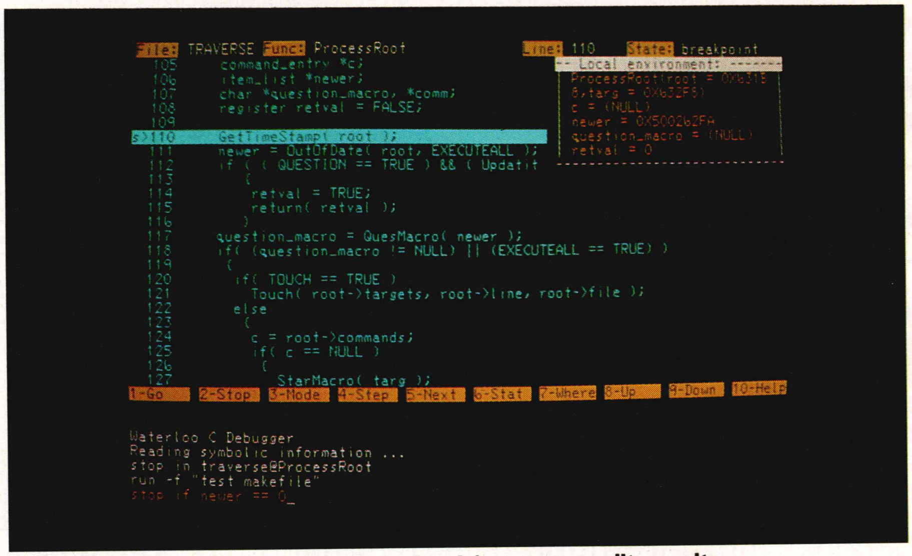

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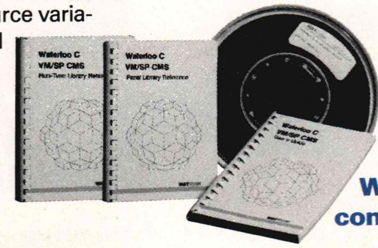

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C CHEST
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performed as follows. The value of the system clock (held in *T_clock*) is copied into the *timestamp* field of the structure. Then all the registers except *SS* and *SP* are pushed onto the current task's stack. Next, the *SS* and *SP* registers are copied into the *ss* and *sp* fields of the TCB. Now the new task is dequeued from the active list and the old task is enqueued in its place. The new task is installed, first by copying the *ss* and *sp* fields into the corresponding registers (thereby making the new task's stack the active stack) and then by popping all the registers. If you've done a context swap, the popped registers will be those that were saved the last time the task was suspended, not the registers that were saved when you entered the timer interrupt-service routine (which are in the suspended task's TCB).

Note that the time of last preemption is considered when a task's priority is examined. That is, if two tasks have the same priority, then the one that has been waiting longest is considered the higher-priority task. This is how round-robin scheduling works.

The other fields in the TCB are used for debugging and message passing. The three debugging fields are *tag*, which points to the string that you passed into *t_create()*; *initial_sp*, which is the initial value of the stack pointer; and *status*, which tells you if a task is currently waiting for a message or not. The kernel doesn't use these fields for anything. The *tag* field is particularly useful because it lets you see which task is actually attached to a given TCB—you can pass the task name to *tcreate()*.

The remaining fields are used for the message-passing system. The *next* field is used to maintain a queue of tasks, all of which are waiting at the same message queue. The TCBs of these tasks are arranged as a linked list, with new tasks being added to the end of the list. The first TCB in the list gets a message when one arrives at the queue. This is accomplished by unlinking it from the list, setting the *msg* field to point

```
        typedef struct tcb
        {
            void            **sp;           /* Task-swap stuff */
            unsigned        ss;

            unsigned        priority;
            unsigned long   timestamp;

            unsigned        wait;           /* Message-management
stuff */
            struct tcb      *next;
            void            *msg;

            int             status;         /* debugging stuff */
            char            *tag;
            void            **initial_sp

            void            *stack[1];      /* Base of system stack
*/
        }
        TCB;
```

Example 1: *The TCB used by the kernel*

```
    typedef struct t_queue
    {
        int             signature;
        struct t_queue  *next;

        TCB             *task_h;        /* Task queue */
        TCB             *task_t;

        int             q_size;         /* Message queue */
        int             numele;
        void            **headp;
        void            **tailp;
        void            *queue[1];
    }
    T_QUEUE;
```

Example 2: *The* T_QUEUE *structure*

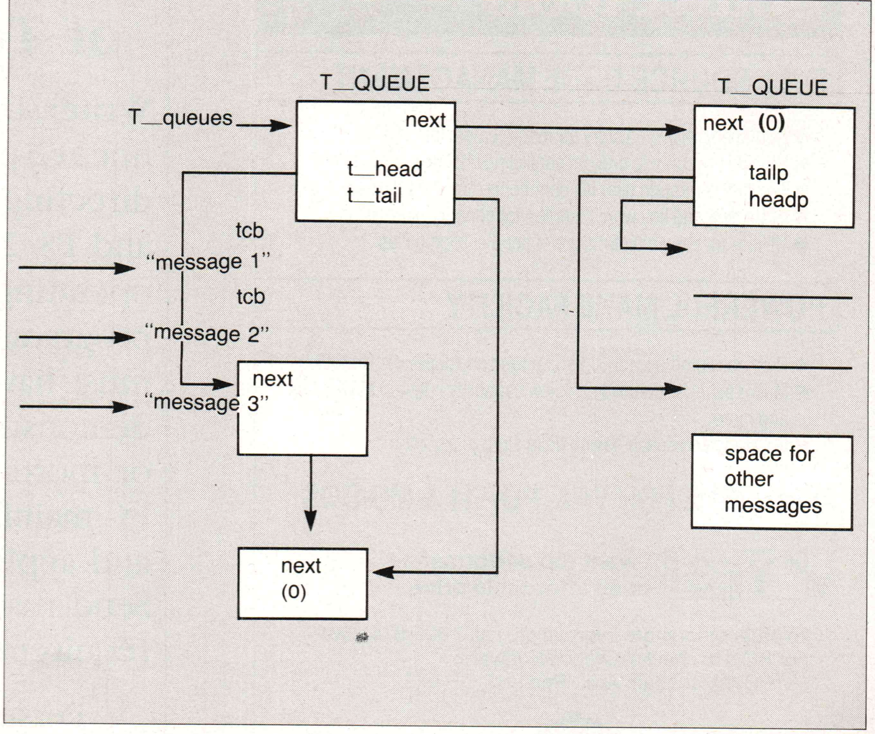

Figure 3: *A list of two queues, the first of which has two tasks waiting at it and the second of which has three messages enqueued and no tasks waiting. Only relevant fields are shown.*

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(continued from page 79)

at the message, inserting the task into the active list, and then forcing a reschedule (as if a timer interrupt had come along). The *wait* field is a counting semaphore. It is initialized to the time-out value that you pass to *t_send()* and is decremented on every timer interrupt. When it gets to 0, the task is removed from the message queue and put back into the active list with the *msg* field set to *NULL*.

The next data structure of interest is the *T_QUEUE* structure, defined on lines 98–113 of Listing One and in Example 2, page 79. *T_QUEUE* is a variable-length structure similar to a TCB. Here, however, the area at the end of the queue is the message queue itself (rather than the stack). *Queue* is the first cell of that area. The *headp* and *tailp* fields point at the head and tail of the message queue and *numele* is the number of messages currently in the queue. The *q_size* field is the maximum number of messages that the queue can hold. Waiting tasks are queued up using the *task_h* and *task_t* fields. The former points to the first element in the linked list and the latter points at the last element.

Self-modifying code turned out to be an easy work-around

The queues themselves are also arranged in a linked list, put together in the order in which the queues are created. The timer interrupt-service routine chases down this second list looking for timed-out tasks. The *next* field points to the next queue in that list; the situation is illustrated in Figure 3, page 79. Finally, the *signature* field contains an arbitrary number that's used by some of the queue functions to make sure that the *T_QUEUE* pointer passed to them is valid.

The Subroutines

Once you understand the data structures, the actual code is pretty straightforward. Schedule.asm (Listing Two) contains the timer-interrupt-related stuff. It is very similar to the *speedup()* subroutine described in the September 1987 C Chest, so I won't go into details here.

_T_speedup() (line 182) speeds up the IBM PC system clock by an indicated factor and installs an interrupt-service routine that does context swaps when required; *_t_slowdown()* (line 241) slows the clock down again and removes the scheduler. *T_block()* and *t_release()* (lines 165–175) just set or clear a global flag (*blocked*, declared on line

C CODE FOR THE PC

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118) that will be examined by the interrupt-service routine, *serv*, on lines 281–345. The flag is checked on line 285, and if it's set, *numblk* is incremented (for statistics purposes only—it tells you how many interrupts were blocked) and control passes to *servexit* on line 327. The code on lines 328–240 vectors to the default DOS interrupt-service routine every *N* interrupts, where *N* is the original speedup factor; otherwise, a nonspecific EOI is issued to the timer chip and an *IRET* is executed.

The actual context swap is straightforward. Registers are pushed on lines 295–302. Note that the *CS*, *IP*, and flag registers are saved by the hardware as part of the interrupt-service procedure, so you don't have to push them again here. The current *SP* and *SS* are saved on lines 306 and 307, a local stack is then installed, and the C subroutine *_t_reschedule( )* is called on line 313. This subroutine (starting on line 512 of Listing Six) scans the list of messages and times out appropriate tasks (in the *for* loop on lines 532–550). It enqueues the running task's TCB and sets *T_active* to the new task's TCB when a context swap is required (on line 567).

Now control returns to the assembly-language code. The new TCB (which is the same as the old one if no swap is necessary) is fetched on line 315 of Listing One. Then the stack is restored, registers are popped, and you keep going. So, if you're doing a context swap, you'll save registers on the old TCB and then restore them from the new one. Note that the *CS*, *IP*, and flag registers are restored as part of the *IRET* instruction.

All the other assembly-language stuff is in swap.asm (Listing Three). The routines in this file are not particularly well structured—that is they save space by sharing code. One subroutine will jump into the middle of another. The central routine is *_t_swap_in( )* on lines 172–242. It is passed a pointer to a new TCB. It suspends the current task and installs a new one as if it were the timer interrupt-service routine. Again, registers are saved (lines 183–198), *T_active* is modified (line 216), and the new task is installed by popping registers (lines 227–242). Note that the subroutine's return address is used as the old task's saved *IP* register. This means that when control is restored to the task, you'll be back in the calling subroutine, just after the *_t_swap_in( )* call.

The other swap-related functions are *_t_install( )* (lines 142–168), which deletes the current task and installs a new one, and *_t_ shazam( )*, which starts up multitasking. Both of these jump into the middle of *_t_swap_in* (to the *shazam* label on line 223) to install the new task. *_T_shazam* also changes the stack probe subroutine, *chkstk*, which is called at the start of all normal subroutines. I couldn't use the normal *chkstk* because the task stacks are in strange places (in the middle of the heap in fact), so the default *chkstk* would always fail. The new routine checks the current

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SP against the current TCB's stack base and reports an error if the stack gets too large.

Note that the installation procedure involves actually modifying the first couple of instructions of the default *chkstk* subroutine to jump to the new one (on lines 271–274). I know this is a kludge, but Version 4.0 of the Microsoft compiler (and early betas of Version 5.0) made it virtually impossible to link in my own *chkstk*. (At least, I tried for a couple of hours with no success.) Self-modifying code turned out to be an easy work-around, but it's a stopgap measure, and I mean to fix it once I figure out how.

The final routine of interest is *__t__stop( )* (lines 94–138), which is called to terminate multitasking. It causes control to pass back to the instruction following the original *t__start* call—the return address was saved by *t__start( )*. *T__stop( )*'s argument is passed back as the return value of *t__start( )*. That is, a call to *t__stop(5)* will cause *t__start( )* to return a value of 5 to its caller. The situation is analogous to an *exit( )* call.

The remainder of the code is straightforward enough and sufficiently commented that there's no need to go through it here. I do suggest that you read it, though. It's pretty interesting. I'll finish with a caveat. I've used the routines printed here in a couple of application programs, and they seem to work fine. These program all use my own direct video I/O functions to write to the screen, however, and they don't do any disk I/O. It's possible to use DOS, but you'll have to implement one of the resource management strategies discussed earlier (or use a nonpreemptive system). Do not call DOS directly from a task without assuring that the task has control of the system for the life of the DOS call.

DBASE has spread like a disease through the small-business community.

I'm reasonably sure that the code presented here is bug free, but I won't swear to it. If you find a bug please report it to me c/o Software Engineering, P.O. Box 5679, Berkeley, CA 94705. Use E-mail to leave a message on CompuServe (because I don't log on reliably enough to guarantee that the message won't roll off the forum message board before I see it). Post a message on the forum, though, so everybody can see it.

Priority-Queue Routines in the Kernel

In addition to the various subroutines presented this and last month, the kernel uses the priority-queue routines from the June 1987 C Chest—you should look at that article for detailed information on how these routines work. I've modified the original code just a bit, however.

The *pq__look( )* routine now returns *NULL* if the queue is empty. It used to return garbage in this situation. I've also added a "replace" routine that replaces the highest-priority element in the queue with a new element, reheaps, and then returns the former top element. It's as if you did a delete of the old element followed by an insert of the new one, but it takes less time than would two operations. Both modifications are shown in Example 3. Also note that a bug fix that affects *pq__insert( )* was mentioned in the August 1987 C Chest, page 108.

```
void    *pq_look( queue )
PQ      *queue;
{
    return queue->nitems ?  queue->heap : NULL ;
}

/*----------------------------------------------*/

int  pq_replace( p, target, item )
PQ   *p;
void *item, *target;
{
    int slots_in_use;

    if( slots_in_use = p->nitems )
    {
        memcpy( target,  p->heap, p->itemsize );
        memcpy( p->heap, item,    p->itemsize );
        reheap_down( p, p->heap );
    }

    return slots_in_use ;
}
```

***Example 3:** The routines* pq__look( ) *and* pq__replace( )

Nifty Stuff: The Lattice dBC Library

Every programmer should have a database management library in his or her toolbox. This month I'll look at one such library—I'll look at others in future columns.

There are a host of database packages on the market, all with their own set of strengths and weaknesses. One of the weakest, from a database management point of view, is Ashton Tate's dBASE III. Unfortunately dBASE has spread like a disease throughout the small-business community. Consequently, it's often necessary to put together a dBASE-compatible application program, even if you'd rather use one of the more efficient database packages.

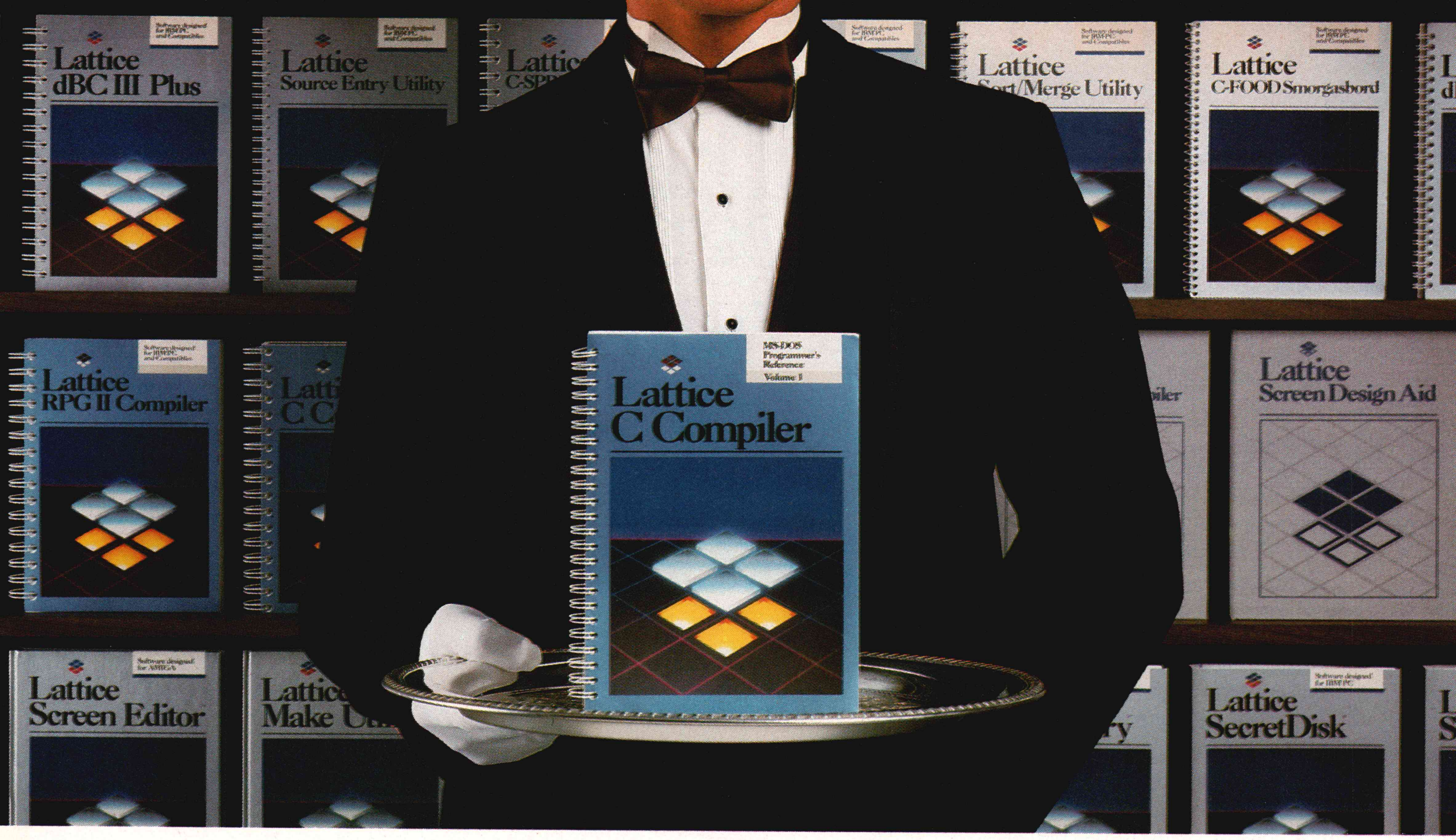
DBASE III is actually a programming language of sorts. In practice, it's so limited and hard to use that

no sane person would write a complicated application in it (at least not if they want to retain their sanity). As a consequence, several fourth-generation languages that support the dBASE file structure, such as FoxBASE and Quicksilver, have sprung up. These products have problems, too—they're limited in one way or another. I want to write my applications in C, not in some inherently inefficient and much too limited 4GL that's really designed for nonprogrammers. My programs will be faster and I can use all the other C functions (such as window management packages) that are at my disposal.

The Lattice dBC III and dBC III Plus packages provide a solution to this problem. These packages are subroutine libraries that you can link into your programs to access dBASE III or dBASE III PLUS databases. The version that I used links to Microsoft-generated code, not Lattice-generated (though versions for the Lattice compiler are available, of course). Versions of the package are available for versions of dBASE down to dBASE II. The main difference between the III and the III Plus version of dBC is networking support (you can lock whole databases, individual records, and bytes within the record). The package comes with small-, medium-, and large-model libraries as well as a demo program (and the sources for the demo program). Though the version that I used expected Microsoft C, Version 4.0, it linked into a program compiled under Version 5.0 without difficulty. (You can't use the new combined libraries, however—the components have to be on the disk.)

I have very mixed feelings about this package. On the plus side, it really does what's required. It took me an hour or so to read the manual, and a few hours later I had a working C program that was accessing a database created by dBASE III PLUS. You should have no difficulty doing the same, even if you've never worked with dBASE itself. Keep all this in mind as you read the negative comments that follow. Though the package has problems, most of them are fixable and dBC is really useful.

Unfortunately, this ease of use has



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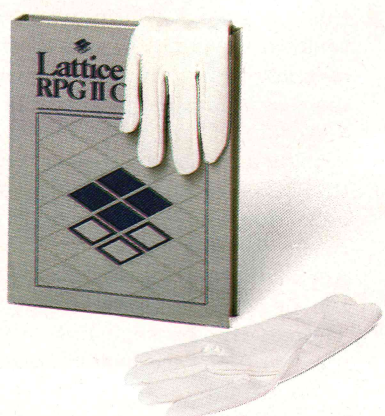

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more to do with the simplistic structure of a dBASE III file than with the Lattice documentation. A chapter that described the organization of dBASE .dbf and .ndx files would have been very helpful. Data is stored in strange ways and an in-depth description of these methods would also be useful. (There's a description of dBASE .dbf and .ndx files in Jeff Walden's *File Formats for Popular PC Software* [New York: Wiley, 1986.])

Some of this information can be gleaned from the subroutine descriptions, but I'd like it all in one place. The manual is poorly organized and hard to use as a reference. For example, dBC functions naturally break into four categories: functions to manipulate the database itself, functions to manipulate the index files, functions to manipulate the memo files, and various formatting functions. The manual, however, is organized alphabetically (generally my preference), but there is no functional index. As a consequence it's hard to find the function you need if all you know is what it does. The subroutine naming conventions are so strange that it's hard to guess what the name will be. The problems with the documentation are compounded by occasional errors in the examples. (One of them has a couple of stars where none belong, an error that caused me about ten minutes of unnecessary head scratching.)

The subroutines themselves are sometimes rather low level. The low-level functions should be included in the package, but higher-level ones are really required, too. For example, there's a host of functions that convert strings and numbers to and from the formats required in dBASE files. Fine, but as a C programmer, I want *sprintf( )*- and *sscanf( )*-like subroutines that would take care of all the details of the conversion for me. Ideally, you'd pass these functions a database pointer, a format string that identified the fields you wanted to access, and several objects to convert—something like this:

```
dprintf( db_file,
         "%name %street %zip",
         "J. P. Morgan", "Easy St.", 09311 );
```

and the function would do the rest for you. No such function is provided, however.

The dBC programming interface is very amateurish and harder to use than is necessary. I'd expect this sort of thing from users' group software but not from professional programmers. There are several problems. First, Lattice has implemented functions with C-like names but with nonstandard interfaces. For example, the function used to open a database is obviously modeled after *open( )*. It's called with:

The package does the job and is easy enough to use.

```
int dBopen( filename, mode, dbffd )

char *filename;
int mode;
char **dbffd;
```

There are several problems here. The main one is that you get back the file descriptor by passing in a pointer to a place to put it (*dbffd*). *DBopen( )* returns an error code, but that's it. I also don't like the declaration of a file descriptor as character pointer. It obviously isn't a string and shouldn't be declared as such. I'd prefer either a *void* pointer or a special type (such as *FILE*).

Were I to rewrite the interface to this function, it would look like this:

```
DBFILE *dBopen( filename, mode )

char *filename;
int mode;
```

It would return –1 on error and a file descriptor on success; there

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would be a *db_errno* that would hold an error code and a *db_perror()* that would print an error message. That is, the dBC function should be identical to *open()*, except that it should open a database rather than a normal file. If you're going to use this package a lot, it would be worthwhile to write a glue library that mapped the weird calling conventions to something more reasonable.

The second problem is the function names themselves. The names are the too-cryptic abbreviations popular with inexperienced C programmers (such as *_dbcmsiz()* or *dBdbfbuf()*). There seems to be a rationale to the naming conventions, but that rationale is never made clear.

Finally, the interface has several built-in inefficiencies. For example, many values are returned from subroutines in a *char* rather than an *int*. (Usually you pass in a pointer to a *char*, which is filled by the subroutine.) This is a classic mistake made by novice C programmers who think they're saving space by shoving data into *char*s. They're wrong. The compiler must convert all *char*s to *int*s before they can be used in an expression. This conversion is always performed, even in expressions that use nothing but *char*-size variables. Not only does the type conversion take time but also the extra code needed for the conversion is usually far larger than the data space saved. The only valid use for C's *char* type is an array of the things.

Frankly, the poor-quality interface makes me wonder about the quality of the rest of the code. The package does work and has been reliable in all the applications that I've written, but I don't really trust it.

In spite of the foregoing, though, I recommend this product to those of you who need to write Ashton-Tate-compatible programs. I intend to keep using it myself in these situations. The package does the job and is easy enough to use. It lets you put together a working program in a reasonable amount of time with a minimum of fuss. Moreover, you can do it all in C, without having to

learn yet another programming language. To make dBC really usable, however, you'll need to add a layer of glue functions to make the program interface more reasonable.

I wouldn't use dBC III Plus if I didn't need dBASE compatibility, however. The ISAM model used by Ashton-Tate is not great for most applications. The databases themselves are poorly structured, generally hard to use, and slow. (The speed is Ashton-Tate's problem, not Lattice's. Any program made with Lattice's package will be an order of magnitude faster than the equivalent dBASE III program. Nonetheless, a database program that used a different model altogether would probably be faster still.) Moreover, the Lattice package is marred by the poor quality of both the documentation and the programming interface. Though you could use dBC for any general-purpose database program, I wouldn't.

Availability

All source code for the multitasking kernel described both this and last month (including the priority-queue stuff) is available for $30 on an IBM PC 5¼" disk from Software Engineering Consultants, P.O. Box 5679, Berkeley, CA 94705. Include local sales tax if you're ordering from California.

In addition to the kernel code and the priority-queue routines, the disk includes an enhanced version of the curses window I/O package described in the July 1987 C Chest. Because the enhanced curses uses direct video reads and writes rather than going through DOS, it's useful in multitasking applications that can't use the DOS I/O functions. This version of curses supports overlapping windows (though you can only write to the top one) and lets you delete and move windows. In addition, it lets you create boxed windows (Unix's curses doesn't).

The (unmodified) priority-queue routines are also available on CompuServe in DL1 of the DDJ FORUM. The file is called QUE2.C.

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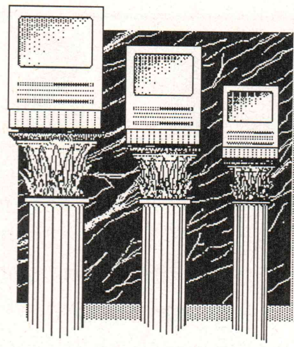
Introduction, Mac Sources, Lightspeed C, and Code Corner



It's been four years now since the Macintosh popped into view, heralded by that great Ridley Scott Superbowl commercial. Though there was obvious brilliance to the design, there were also strong whiffs of arrogance and hype. But, hey, I've been accused of the latter myself. There was nothing to do but pop out of the hills and take a closer look.

I cruised over the Siskiyous to see my Apple dealer buddy, John Manzer. I got to the store, chewed the fat a few minutes, scanned the marketing propaganda, nosed the technical specs, then plunked down at the machine. Cynical musings twisted my mind, but what the hell, let's start 'er up.

I didn't like the locked hardware. I didn't like the one drive. I didn't like the lack of a hard disk. I didn't like the price. I didn't like the (hah hah) wide selection of printers. I didn't like the yuppistic overtones.

But I loved the machine. It was fun to use. Oh, there were flaws, but they seemed minor compared to what the creators got right. Above all, the interface snapped. It didn't have a speed snap—not yet—but rather the feel-of-a-fine-tool kind of snap. The Macintosh communicates via clean visual metaphors, and that's a channel with a lot of bandwidth. Something about the Macintosh interface just feels good, like soft light filtering through a redwood forest or playful kittens careening and bouncing about the world. People needed to use computers like this. I needed to program computers like this. Yow!

by Stan Krute

Four years of good nurturing has led to some lovely growth. We've got a wide array of languages, detailed system documentation, the LaserWriter, Mac IIs, Hypercard, MultiFinder, and some remarkable application software. The platform's been consolidated, and the best is yet to come. Happy birthday, Mac! Blow out those candles, eat up that cake, chug down the Jolt, get crazy with your buddies. Hell, Maddie Hayes's got you in her office: Y'all done good.

The Doc Gets a New Column

And so *Dr. Dobb's* gets a Mac column. What'll I do here?

1. Take note of well-done applications and extensions to the user interface.
2. Review a wide array of Mac programming tools: software and works on paper.
3. Talk with, and about the work of, innovative Mac programmers.
4. Discuss some of the more interesting algorithms and data structures contained in the Mac ROM/OS. This thing's a graduate course in programming, with interesting tidbits lurking between every *LINK/UNLK* pair.
5. Write some code. Mac programming's the most addictive fun I've had in the innards of a machine. The universe of the Mac ROM/OS is quite dynamic, so there's a premium—nay, an imperative—on programming that's clean, concise, and careful. Yield to that imperative, then combine it with an interface design that syncs with the Mac paradigm, and you get applications that not only work but that are also fun, easy to use, empower your users, and smack of elegance.
6. Provide access details. I'll always give you a box (see page 106, for example) filled with information that'll help you get hold of items mentioned in that month's column.

Reviews, Criticism, Objectivity

It's a lot of hard work to get a book or software product on the market. I feel a special obligation to creators to be scrupulously fair with any review/comments/criticism of a work. Print's powerful stuff. If I think something is seriously flawed, I won't even bother to mention it here; I prefer to send a quiet note detailing my qualms directly to the publisher. I'd rather put this column's energy into feeding awareness of the good stuff.

A note on objectivity: I'm lucky enough to know and/or have worked with some of the people whose products I may mention. But it does nobody any good if I let that shade my opinions. On the other hand, I don't want to ignore a good product just because I've had something to do with it. So I'll always mention any close connections I've got to a particular item in an objectivity note. Just know that it's done to help you weigh my opinions, not as name dropping.

Getting Up To Speed

The code samples I'll be showing aren't for raw beginners. This is *DDJ*, after all. But it's easier to get up to Mac programming speed now than it was in the early days. A lot of resources are available to help you cruise the learning curve. Here's a minimal list:

1. Join APDA, the Apple Programmer's and Developer's Association. Godchild of Dan Cochran and Dave Lingwood, this is a one-stop source for draft and finished copies of Apple documentation and development tools as well as a wide variety of third-party products. Dues are a reasonable $20 per year, it has an

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800 phone number, and you can charge to plastic.

2. If you're developing commercial products, try to become a certified Apple developer. Most important, this gives you access to Apple's electronic-mail technical support. Within the corporate constraints, the remarkable tech support humans will help you work through most any problem. Answers come within 24 hours. Other certified developer pluses: marketing assistance, developers' conferences, discounts on development hardware, and a tinge of credibility.

3. Get *Inside Macintosh* and its descendants. If the Pulitzers had a technical writing category, *Inside Mac* would own a prize. Caroline Rose and her cohorts and descendants have given us the most comprehensive insight into a complex cybernetic system yet seen. This is the starting point for all Macintosh programming. Take a look at the APDA newsletter for the latest volume count. The only flaw is a lack of practical examples, but other folks have filled that gap (see next item).

4. Add at least the following five books to your library: Scott Knaster's *How to Write Macintosh Software*, Dan Weston's *The Complete Book of Macintosh Assembly Language Programming (Volumes I and II)*, *The Best of MacTutor*, and *The Complete MacTutor*. Other fine Mac programming books are available, but these five are classics. They give you the practical examples that *Inside Macintosh* lacks. And, if you share my lack of photographic memory, you'll also want some language references. I like the handy little *Signetics S68000 User's Guide* for 68000 assembly language and Harbison and Steele's *C: A Reference Manual*. (Objectivity note: Dan Weston is a longtime friend and fellow traveler.)

5. After you've reupped with *DDJ*, subscribe to *MacTutor*. It's one great Macintosh programming magazine, filled each month with nerdly little programming goodies.

6. Put together an array of development tools. Plenty of good ones are available, and every now and then, I'll review some here in the column.

After all, I'm a language junkie; one of the perks of this gig is feeding the addiction guilt-free.

Choosing development tools is pretty personal. With one exception (now justly dead in the market), I haven't hit a Mac programming tool that someone wouldn't find useful in some context. The Mac environment must have some kind of inspirational effect. You'll have to follow the usual path to find personally amenable tools: talk to friends, read reviews, scan the ads, ask questions on the networks, play around. For what it's worth, here's a commented list of what I currently find myself using; note that most of my Mac work is done in C, with 68000 assembly language for speed tweaks and writing specialized code resources.

- C compiler: Lightspeed C 2.11—blazingly fast, holds to standards, feels good.
- 68000 assembler: MDS 2.1—I started here and have found no reason to move on; now marketed as the Consulair 68000 Development System.
- Debugger: TMON 2.8—clean, simple, powerful, can survive a lot of weirdness.
- Text editor: QUED/M 2.04—solid, feature-packed, useful macro language, very nice.
- Resource editor: ResEdit 1.1B1—one of the unsung great hacks, this Apple-produced program is the Mac-like way to create and manage resources.
- Disk and file editor: Fedit Plus—does anything you can think of to disks and files, fast and accurate with a very clean interface. (Objectivity note: I worked on the latest Fedit Plus documentation.)
- Code snooper: MacNosy—allows intelligent examination of any piece of code you can specify, including and especially the ROM. (Objectivity note: I worked on the [little yellow book] MacNosy documentation.)

7. Get a Mac with a hard drive and as much memory as you can afford. Anything less will drive you nutso fast. Hey, I oughtta know: I did my first Mac programming in assembly language on a 128K one-drive machine with 8-minute turnarounds. With a language such as Lightspeed C or Turbo Pascal on a multimeg SCSI machine, turnarounds drop down into the sub-30-second range.

Useful Mail-Order Sources

When I'm not traipsing around civilization as a cybernetic nomad, I live in the middle of nowhere, so I have to rely on mail-order sources to get programming books, software, and miscellaneous supplies. I've found a couple of good ones I'm happy to share with you.

For books, I use Computer Literacy. This bookstore carries just about everything, takes credit cards, and ships UPS the day you order. For software and supplies, I use Computerware. It specializes in the Mac, also takes credit cards and ships UPS quickly, and has an 800 phone number. Both these places have retail outlets well worth a visit if you're in Silicon Valley.

Don't Trash Your Old Mac

Apple's Macintosh upgrade path has been a little bumpy. A lot of folks still have 512s, possibly upgraded from 128s, and wonder whether it's worthwhile doing any further upgrading. Here's what I did: got Apple's 800K drive/128K ROM upgrade ($300 at an Apple dealer), then added SuperMac's Enhance board

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($500 installed at Fry's Electronics). Enhance brings your Mac up to 2 megabytes (expandable to 6.5 with high-capacity SIMMs), gives you a slight speed increase, and adds a SCSI port and a small internal fan.

I had one problem with the parasitic clip that plugs Enhance into the motherboard's 68000, but SuperMac kept Federal Expressing me replacements until we had the problem licked—no problems since then. I get a big grin on my face when my original 128K Mac comes up on a speedy hard disk with megabytes of RAM at its disposal.

Lightspeed C

It's hard to hold in my feelings on this product. Let's just say this: I love it. Michael Kahl and the rest of the Think Technologies crew have given us something wonderful. This thing is fast—makes me want to stick some flame decals on the Mac. Working in the LSC environment's a tasty treat, and I for one refuse to go back to anything slower or less capable.

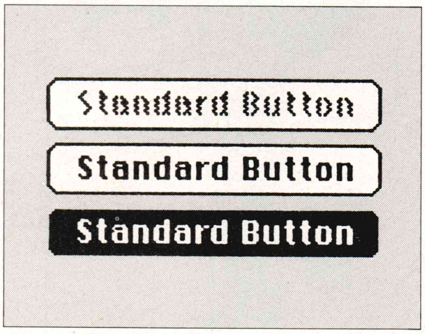

Figure 1: *Standard button in its three highlighted states—inactive, active, and highlighted*

Producing robust Mac code is (for me, at least) a highly iterative process. It bears repeating: Mac software exists in a very dynamic universe. The slightest coding miscue quickly propagates into screen-twisting madness. Debugging is tricky—well worth avoiding—so I like to write my code in snippets, testing and debugging each piece thoroughly before moving ahead. Lightspeed C, with its blazing turnaround speed, lets me do this painlessly.

A lot of attention's been paid to the product's details. Work goes on in a well-integrated project environment. Nitty little maintenance details are automated. The language, libraries, and header files hold closely to the relevant standards (Unix, Kernighan & Ritchie, Harbison & Steele, the evolving ANSI C, and *Inside Macintosh*). The editor's good—not quite so feature-laden as QUED/M but good—with powerful grep capabilities. The compiler puts out code that's fast and compact. It's easy to produce the various sorts of Macintosh code, with global and static variables available in each: double-clickable applications, desk accessories, device drivers, and code resources. In-line assembly-language code's allowed, with full access to the C name spaces. Resource file management is completely automated. Register variables are maximal: five data registers and three address registers. HFS and MultiFinder are well supported.

variation	content	border	highlighting via
0	text	outlined	inversion
1	text	outlined	content change
2	text	shadowed	inversion
3	text	shadowed	content change
4	PICT	bare	inversion
5	PICT	bare	content change
6	PICT	outlined	inversion
7	PICT	outlined	content change
8	PICT	shadowed	inversion
9	PICT	shadowed	content change
10	ICON	bare	inversion
11	ICON	bare	content change
12	ICON	outlined	inversion
13	ICON	outlined	content change
14	ICON	shadowed	inversion
15	ICON	shadowed	content change

Figure 2: RectCDEF's *16 button variations*

I recently had the pleasure of spending a September afternoon at Think headquarters doing free-form nerd talk with Michael Kahl (the prime Lightspeed C programmer), Andrew Singer (head of Think and coconceiver of Lightspeed), and Doreen Duplin (marketing/communications whiz). These are nice people in whom the joy of the great hack runs deep. Interesting backgrounds: Michael was a philosophy grad student before succumbing to the lure of machine logic. Andrew's known to many of us for his classic (and, sadly, out of print) Sherlock Holmes pastiche programming books *Elementary BASIC* and *Elementary Pascal*.

Recent releases of both Lightspeed C and Lightspeed Pascal (2.13 and 1.11A, respectively, as this column is written) have been maintenance releases, keeping the languages current with the latest Mac machinery and system software. In the works, though, are major new releases of both languages. Look for greater speed and, for Lightspeed C, powerful debugging capabilities. "It's time for another dose of the spectacular," quoth the Singer.

I wish I had room to give you a complete transcript of the afternoon's conversations. The Thinkers said a lot of smart stuff. Maybe in a future column. Meanwhile, take this as a bottom line: if you program the Mac in C, check out Lightspeed.

Code Corner

All right, time to get down to a little code hacking. My first project involves writing and using a custom control definition. Because of space constraints, I'll describe the project in two phases, continuing the discussion in next month's column.

Macintosh applications are rife with controls: buttons, scroll bars, check boxes, radio buttons, et al.

TO THE MACS

(continued from page 94)

Definitions for standard controls are built into the Mac ROM/OS—there's the standard button, for example. Clicking a standard button with the mouse makes things happen. Standard buttons have three basic states, each with a corresponding visual metaphor: inactive, when the button won't respond to a mouse click; active, when the button will respond to a mouse click; and highlighted, when the button's in the midst of being clicked. Figure 1, page 94, shows a standard button in each of these three states.

But you also have the ability to define, via a CDEF code resource, your own buttons. The CDEF resource can then be incorporated into an application and can be called upon whenever the application wants to put a button on the screen. Custom CDEFs are not very difficult to write and can provide a lot of flexibility at low memory cost. The CDEF I'll be showing you in this column, for example, is less than 1,400 bytes long yet it provides 16 new types of buttons—that's less than 88 bytes per button variation. Such a deal.

Development Details

I wrote my CDEF, called *rectCDEF*, in assembly language using MDS 2.1. That's because I wanted high execution speed and small code size. I wrote a demo application in C that shows off the 16 button types using Lightspeed C 2.11. Resources for the application were put together with ResEdit 1.1B1. PICTures for particular buttons were drawn in SuperPaint 1.0p, then transferred into ResEdit via the Scrapbook.

I first got the demo application up and running, albeit with just one control, that being of button variation 0 (see later). Then I started work on the CDEF. As I worked on the CDEF, I used an Exec JOB file to assemble the code, link it, turn it into a resource, then merge that resource into the demo application for testing. I worked on one variation at a time, adding a control of that type to the demo application, then fixing the CDEF to cover that case.

Any particular CDEF can have up to 16 variations. (Actually, you can hack in a few thousand, but that technique's for another article.) I used all 16 in *rectCDEF*. The *rectCDEF* buttons live in a rectangular world. A particular button variation can contain text, a picture, or an icon. Text can be in any font/size/style combination the Mac's capable of. A button variation can have a simple outline, a shadowed outline, or (unless it's a text variation) no outline. A button variation can indicate highlighting via inversion or a change of content.

Figure 2, page 94, details the 16 *rectCDEF* button variations. Figure 3, page 98, shows examples of each variation, with pictures of the active and highlighted states.

An Overview

The demo program, imaginatively named custom controls demo, puts up a modal dialog containing examples of *rectCDEF* buttons, then responds to button clicks. Figure 4, page 100, is a screen snapshot of the program's modal dialog. Using a modal dialog simplified the program's event-handling logic; it's a nice technique for bench testing new routines.

Figure 5, page 100, shows the files

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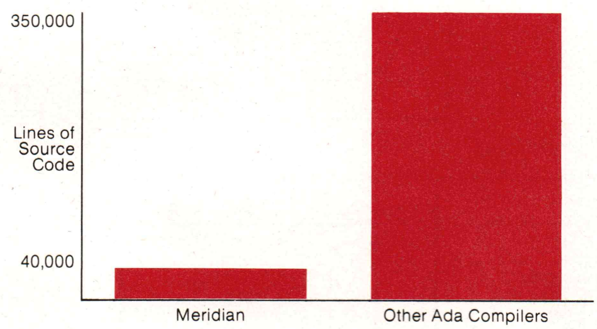

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involved in the demo program. Custom controls demo PROJ is an LSC project file that contains the C source code file; custom controls demo.c (see Listing One, page 54); and MacTraps, the LSC library that hooks code into the Mac ROM/OS (see Figure 6, page 100). Custom controls demo.h, in Listing Two, page 64, is a file of private definitions for custom controls demo.c. Custom controls demo PROJ.rsrc (available on CompuServe and the *DDJ* listings disk) is a collection of program resources, including *rectCDEF*, that gets bound into the final application. It was put together with ResEdit. Finally, custom controls demo

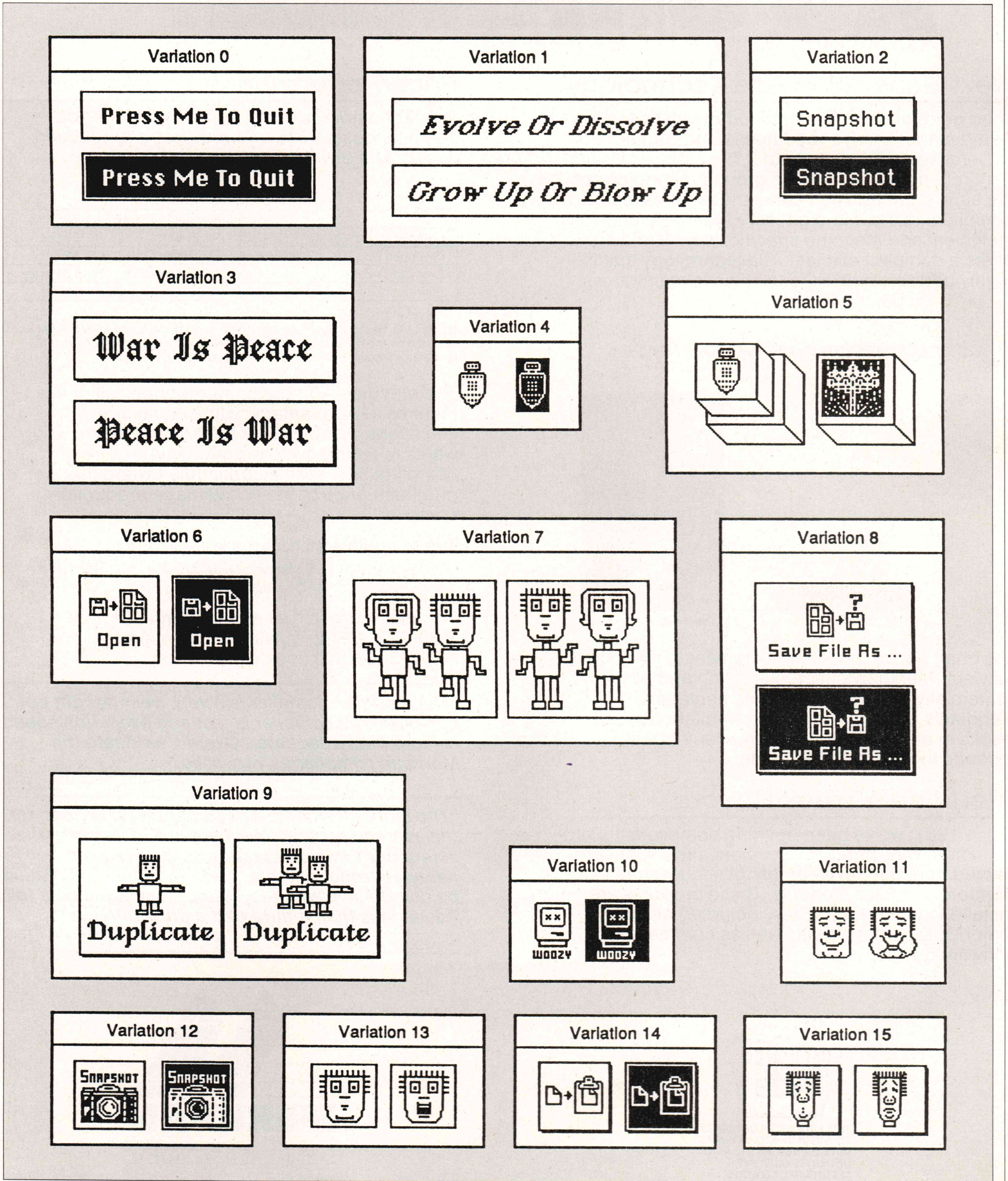

Figure 3: *Samples of the 16* rectCDEF *variations in active and highlighted states*

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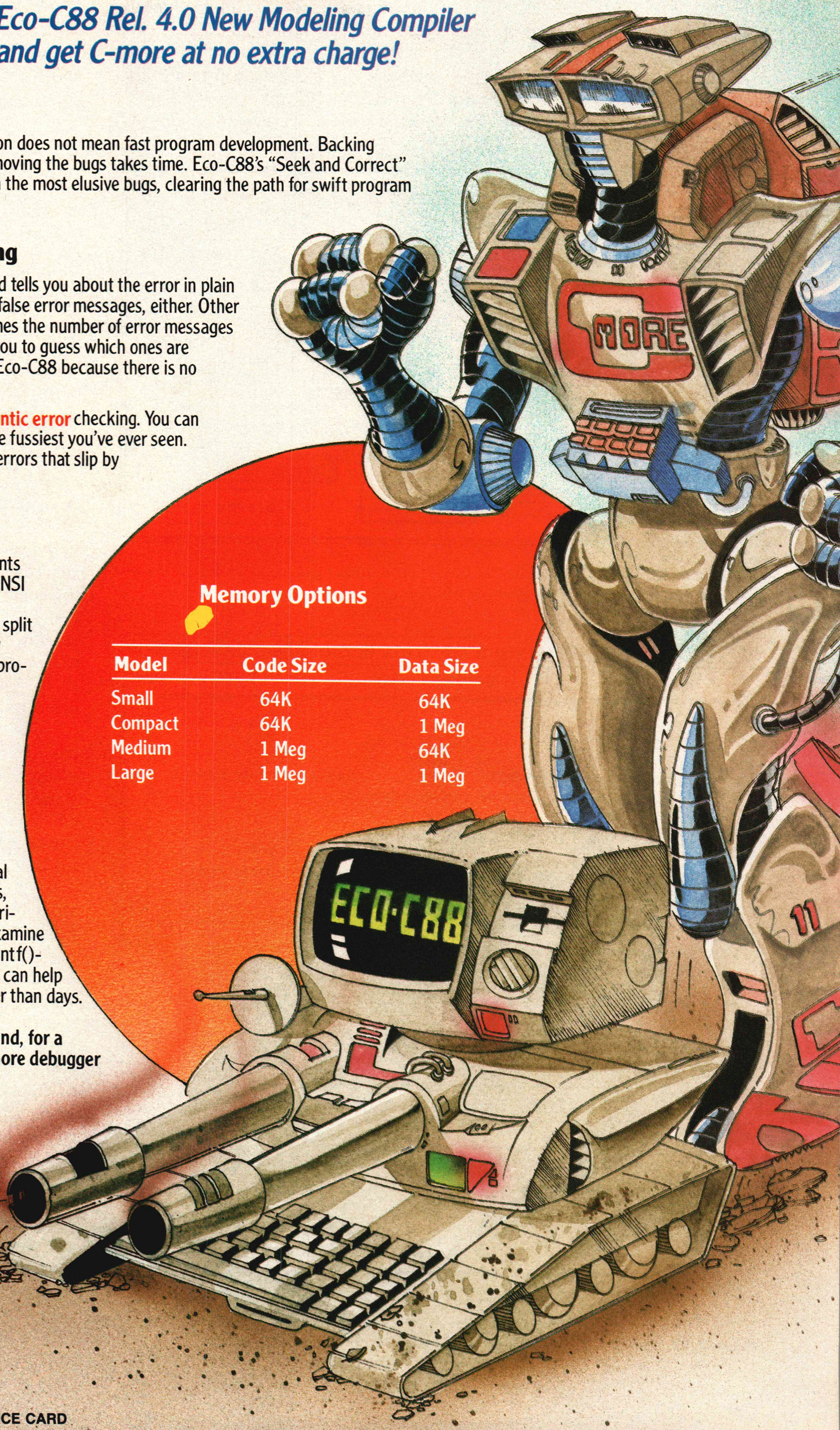

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TO THE MACS
(continued from page 98)

is the double-clickable final application.

Although it's small and simple, custom controls demo.c follows the classic pattern of Macintosh programs. First come a few setup activities. Then the program sits in a main event loop, waiting for events of interest. When such an event occurs, the program figures out what's up, acts appropriately, then returns to the main event loop. At some point an event occurs that tells the program to pop out of the main event loop. Then come a few cleanup activities, followed by an exit to the OS shell.

Each control button in custom control demo's main modal dialog has a corresponding item number in the DITL resource that supplies the dialog. Figure 7, page 101, matches each item with its DITL item number. These numbers are given symbolic names in the header file custom control demo.h. The same numbers are used for the CNTL template resources that each DITL item points to.

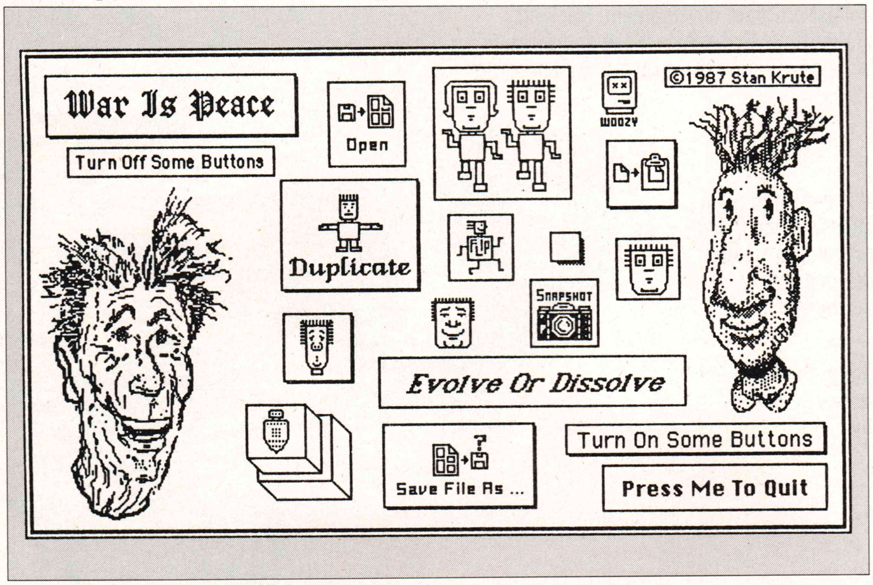

Figure 4: *Custom control demo's main modal dialog*

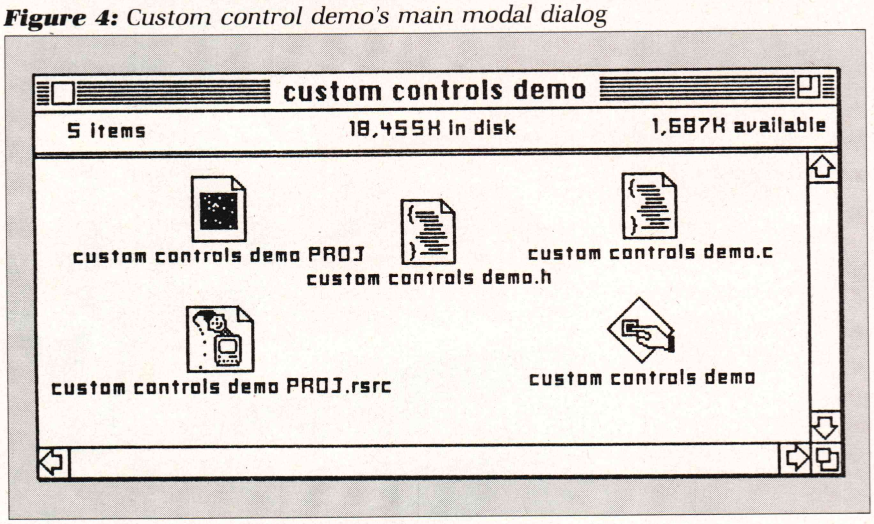

Figure 5: *Five files used by Lightspeed C to build the program custom controls demo*

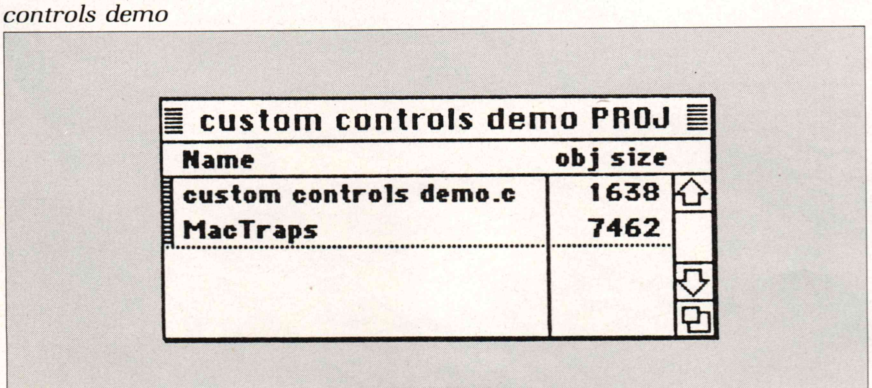

Figure 6: *The LSC project file used to build custom controls*

A Few Function Notes

If you've done your homework, the demo program should seem trivially simple, so I won't go into massive descriptive detail. That'll get saved for next month when it's time to cruise the *rectCDEF* assembly-language code. Here are a few notes:

main—Sets up the Mac managers, gets the modal dialog going, runs the main event loop, then cleans up and exits when all is done. Note the substitution of the ROM call *ModalDialog* for the usual *GetNextEvent* as the heart of the program's main event loop.

inititializeManagers—Grabs some master pointers, forces the heap to grow and clean itself, gets the ROM/OS managers up and running, flushes the event queue, and brings up the standard arrow cursor.

studyAndSetEnvironment—Figures out the size of the screen and menu bar. This information is used later on to position windows neatly.

getThatDialogCookin—Brings the main modal dialog into memory, positions it on the screen, sets its font to Geneva 12, then makes it visible. Note well: it's a good idea to use dialog and window templates that come up invisibly. Then you can bring them into memory, pull off any adjustments in private, and use *ShowWindow* to make them appear.

dealWithDialogItem—Just a big switch statement to case out on the button that got clicked in the main event loop. The top layers of a Mac

application are usually filled with such switch statements as the program zeroes in on exactly what kind of event occurred and what to do about it. Note how the *quitItem* button controls the main event loop via the global Boolean variable *finished.*

The following nine routines deal with the clicks of specific buttons:

doOrwellItem—The *orwellItem* button stays highlighted while the *ronItem* button fades in and out.

doSnapshotItem—The *doSnapshotItem* button lets you take action pictures of the demo program via a call to a Camera desk accessory. If you don't have such a DA in your system file, the *OpenDeskAcc* call returns without crashing.

doMushroomItem—Similar to *doOrwellItem*. This time the *bumperStickersItem* fades in and out of view.

doOpenItem—Calls on the standard file-opening routine, then does nothing with the routine's result.

doSaveAsItem—Calls on the standard file-saving routine, then does nothing with the routine's result.

doFlipItem—Takes a list of content-changing buttons, then runs them through a little animation routine by turning highlighting on and off.

doSomeOffItem—Takes a list of buttons and makes them inactive.

doSomeOnItem—Takes the same list of buttons passed to *doSomeOffItem*

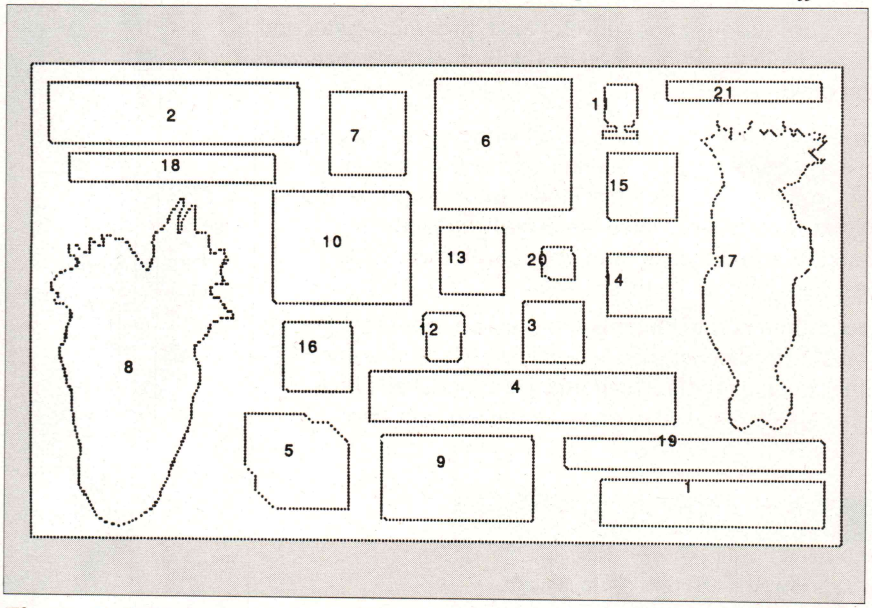

Figure 7: *DITL item numbers for each of the controls in custom control demo's main modal dialog*

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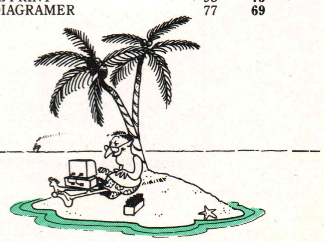


CIRCLE NO. 170 ON READER SERVICE CARD

TO THE MACS
(continued from page 101)

and makes them active.

doCopyrightItem—Brings up a modal dialog that expresses the author's interest in legal protection for works of art.

figureCenteredRectTLC—I don't know about you, but I go nuts over programs that don't know how to position things on different-size screens. This little routine shows how simple it is to be tidy.

To be continued next month.

Wrap Up

Special thanks go to the following for thoughts and actions that made this month's column possible: Tom Atkinson of Orchard Computer, Cynthia Bruschi of ICOM Simulations, Dan Cochran of Apple, Doreen Duplin of Think Technologies, Bruce Hammond of Starpoint Software, Michael Kahl of Think Technologies, Jerzy Lewak of Paragon Concepts, John Mitchell of Apple, David Perlman of Action Graphics, Andrew Singer of Think Technologies, Nathan Slemmer of Interstate Computer Bank, Tyler Sperry of *DDJ*, Mike Swaine of *DDJ*, Levi Thomas, and Dan Weston of Nerdworks.

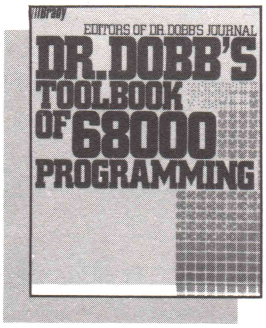
This is the first of my *DDJ* Mac columns. Feedback pro and con will be much appreciated; my access information is at the end of the column. Hot tips, keen insights, funny problems, and review copies of books and software are also solicited.

Next month for sure: assembly-language source for *rectCDEF* along with copious explanation and the rest of custom control demo's resources.

Next month maybe (depending on time, space, and circumstance): hypertalk secrets, living with multiFinder, macdraw with a brain, parasitic desk accessories, talks with various programming luminaries, and Microsoft madness revealed.

Stan Krute, when not serving as DDJ's new Mac columnist, is an artist, programmer, writer, and teacher. You can reach him via MCI

Programming Tips



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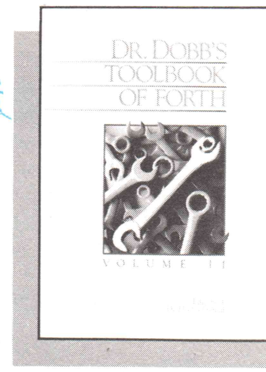

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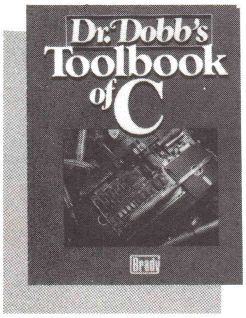

Dr. Dobb's Toolbook of C

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This authoritative reference contains over 700 pages of the best C articles and source code from *Dr. Dobb's Journal of Software Tools*, along with new material by C experts. You'll find hundreds of pages of useful C source code, including a complete compiler, an assembler, and text-processing utilities. Also included: all of Anthony Skjellum's C Programmer's Notebook columns distilled into one thought-provoking chapter.

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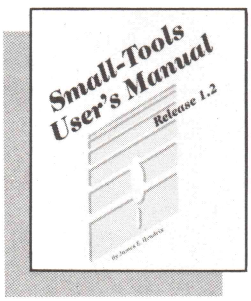

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by James E. Hendrix

This package of programs performs specific, modular operations on text files, including: editing; formatting; sorting; merging; listing; printing; searching; changing; transliterating; copying; concatenating; encrypting and decrypting; replacing spaces with tabs and tabs with spaces; counting characters, words, or lines; and selecting printer fonts. **Small-Tools** is supplied in source code form. With the **Small-C Compiler**, you can select and adapt these tools to your own purposes. Documentation is also included. Available for MS-DOS or CP/M systems. Please specify format.

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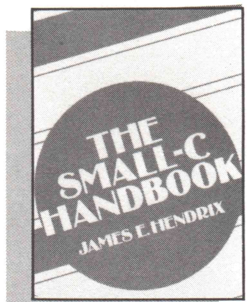

The Small-C Compiler and Small-C Handbook

by James E.Hendrix

This compiler and handbook provide everything you need for learning how compilers are constructed, and for learning C at its most fundamental level. You'll find a discussion of assembly language concepts and program translation tools, and learn how to generate a new version of the compiler. Full source code is included. The handbook and compiler on disk are available for both MS-DOS and CP/M systems. The handbook comes with an addendum for the MS-DOS version. Please specify format.

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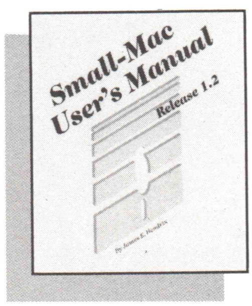

Small-Mac: An Assembler for Small-C

by James E. Hendrix

This assembler features simplicity, portability, adaptability, and educational value. The package includes: a simplified macro facility; C language expression operators; object file visibility; descriptive error messages; and an externally defined instruction table. You get the macro assembler, linkage editor, load-and-go loader, library manager, CPU configuration utility, and a utility to dump relocatable files. Documentation is included. For CP/M systems only. Please specify format.

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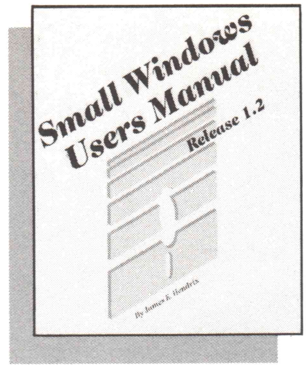

Small-Windows: A Library of Windowing Functions for the C Language

by James E. Hendrix

Small-Windows is a complete windowing library for C (Microsoft 4.0 and Small-C). The package includes: 18 video functions written in assembly language; 7 menu functions that support both static and pop-up menus; 41 window functions to clean, frame, move, hide, show, scroll, push, and pop windows. Two test programs are provided as examples to show you how to use the library and the window, menu, and directory functions.
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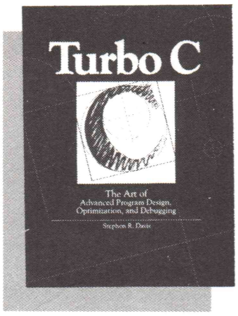

Turbo C: The Art of Advanced Program Design, Optimization and Debugging
by Stephen R. Davis

Overflowing with example programs, this book fully describes the techniques necessary to skillfully program, optimize and debug in Turbo C. Every topic and Turbo C feature discussed is fully demonstrated in Turbo C source code examples. Advanced topics such as pointers; direct screen I/O; inline statements in Turbo C; and how to intercept and redirect BIOS calls are all covered in depth. The author further demonstrates these advanced topics by writing a RAM resident pop-up program in Turbo C. In addition, the author fully outlines the differences between Unix C and Turbo C; the transition from Turbo Pascal to Turbo C; and the superset of K&R C features implemented in Turbo C and included in the proposed ANSI C standard.

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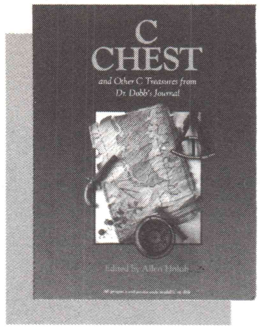

C Chest and Other C Treasures from Dr. Dobb's Journal
by Allen Holub

This comprehensive anthology contains the popular "C Chest" columns from *Dr. Dobb's Journal of Software Tools*, along with the lively philosophical and practical discussions they inspired, in addition to other information-packed articles by C experts. Topics covered include: pipes, wild-card expansion and quoted arguments; sorting routines; command-line processing; queues and bit maps; utilities such as ls, make, and more; expression parsing; hyphenation; IBM cursor control and an Fget that edits; redirection; accessing IBM video display memory; trees; an AVL tree database package; directory traversal; sets; shrinking .EXE file images; hashing, expressions, and Roman numerals; and statistical applications of digital low-pass filters. Other treasures include: a variable metric minimizer; Fgrep; a peephole optimizer; and curve fitting with cubic splines.
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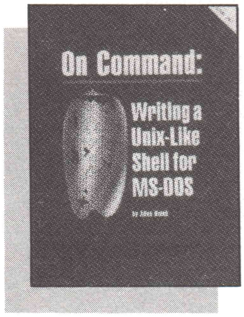

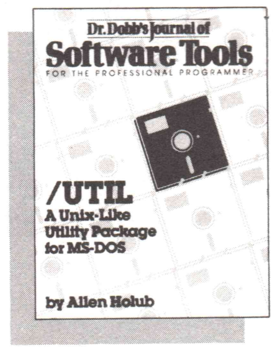

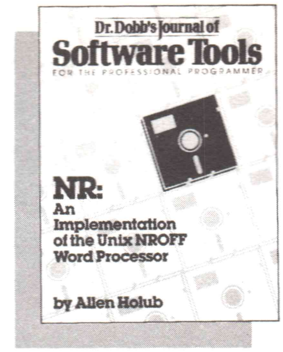

On Command: Writing a Unix-Like Shell for MS-DOS

by Allen Holub

This book and ready-to-use program demonstrate how to write a Unix-like shell for MS-DOS, with techniques applicable to most other programming languages as well. The book and disk include a detailed description and working version of the Shell, complete C source code, a thorough discussion of low-level MS-DOS interfacing, and significant examples of C programming at the system level.

Supported features include: read, aliases, history, redirection and pipes, Unix-like command syntax, MS-DOS-compatible prompt support, C-Shell-based shell scripts, and a Shell variable that expands to the contents of a file so a program can produce text that is used by Shell scripts. The Unix-like control flow includes: if/then/else; while; foreach; switch/case; break; continue.

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by Allen Holub

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by Allen Holub

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DDJ

(Listings begin on page 54.)

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Object-Oriented Programming in Pascal

Object-oriented programming has become quite popular in the last few years. One aspect of its growing acceptance is the increasing number of structured and AI language implementations that support this new paradigm—for example, there are object-oriented implementations in C, Pascal, LISP, Logo, and Forth. In recognition of the magazine's focus this month on the 68000 line, I'll look at a new object-oriented Pascal available for the Macintosh.

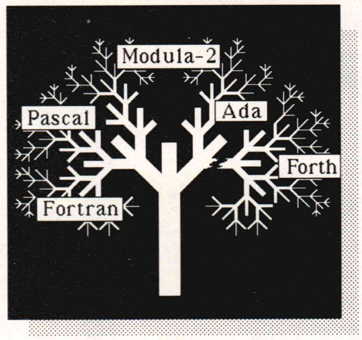
The strength and attraction of object-oriented programming is that it offers you both a new concept (or technique, if you like) for modular coding and a method for efficiently describing a hierarchy of data structures (because redundant components need not be redeclared).

Objects in Pascal can be regarded as highly evolved record structures. Objects declare instance variables (similar to fields of Pascal records) and instance methods, or methods for short. These methods are routines that manipulate the objects. Consider the following object-type declaration:

```
TYPE TRectangle = OBJECT
   { instance variables }
   Length,
   Width : real;
   { instance methods }
   FUNCTION Area : real;
   FUNCTION Circumf : real;
   FUNCTION Diagonal : real;
END;
```

by Namir Clement Shammas

which declares a class of objects named *TRectangle* that contains two instance variables—namely, *Length* and *Width*. Three methods are supplied to calculate the rectangle's area, circumference, and length of diagonal. The declared methods (all of which are functions in the pre-



ceding example) are implicitly *FORWARD* declarations of the routines' headings. The actual code is placed after all the other declarations.

To use the *TRectangle* object type, I must declare a variable and then allocate its dynamic memory using the predefined *NEW()* procedure. Accessing the fields and routines employs the familiar dot notation used with Pascal records. Consider the following code fragment:

```
VAR Rect : TRectangle;
   A : real;

BEGIN
   NEW(Rect);
   Rect.Length := 8.0;
   Rect.Width := 5.0;
   A := Rect.Area;
```

In this code the name of the object is used in conjunction with all the object's instance variables and methods.

A rectangular parallelepiped is a 3-D rectangle that can be regarded as extending the 2-D "parent" shape into a third dimension. This means the parallelepiped shares the same features as the 2-D rectangle and adds a few new ones. To enable the parallelepiped objects to inherit the features of the 2-D rectangle, I declare the following:

```
TYPE TSolid = OBJECT(TRectangle)
   height : real;
   FUNCTION Volume : real;
   FUNCTION Space_Diag : real;
END;
```

This declaration states that the object type *TSolid* is a child of the object type *TRectangle*. As a child object, it is able to inherit all the instance variables and methods of its parent object:

```
VAR Solid : TSolid;
   A, V : real;

BEGIN
   NEW(Solid);
   Solid.Length := 8.0;
   Solid.Width := 5.0;
   Solid.Height := 7.0;
   A := Solid.Area;
   V := Solid.Volume;
```

Notice how the variable *Solid* (of type *TSolid*) is able to access the instance variables and methods of the *TRectangle* object type directly. Unlike nested record structures in Pascal, nested objects can make direct reference to the ancestor's variables and methods.

In the preceding discussion, I pointed out that the class of objects *TSolid* is able to inherit components from its parent object. Object-oriented Pascal provides a convenient mechanism to enable a new subclass of objects to define its own version of certain inherited methods. Such methods offer either additional or alternate ways of manipulating an object.

Consider, for example, the case of making an alternate definition of the object type *TSolid*. I want to rename the method *Space_Diag* as *Diagonal*. Because the *Diagonal* name is also used by a method in object *TRectangle*, I must resolve the conflict I have just created. The keyword *OVERRIDE* is used to override inherited versions, so my new alternate declaration for the *TSolid* object type is:

```
TYPE TSolid = OBJECT(TRectangle)
   height : real;
   FUNCTION Volume : real;
```

FUNCTION Diagonal : real; OVERRIDE;
END;

The *OVERRIDE* keyword is placed after the sought method, followed by a semicolon. To revert to the method inherited from a parent object type, instead of the overridden method, the keyword *INHERITED* must be placed before the method in question.

In certain cases it may be necessary to make a reference to an object associated with a method. Object types are similar to pointers, and hence they must be dynamically allocated. A problem arises because methods cannot allocate the objects they manipulate. To solve this dilemma, object-oriented Pascal provides a special identifier, *SELF*. Using *SELF*, you can make references to the object that is yet to be created—for example, the code for method *Volume* can be written as:

```
FUNCTION Volume : real;
BEGIN
  Volume := SELF.Length *
      SELF.Width *
      SELF.Height;
END;
```

TML Pascal for the Mac, the only object-oriented Pascal implementation I've seen, allows you to omit the *SELF* reference.

A Sample Program

Object-oriented programming can be applied across the board, including with basic data structures. Listing One, page 66, shows a complete TML Pascal program that implements simple objects to represent various types of simple numeric stacks.

The first object defined, *TStack*, contains instance variables and methods used by all the other object types. In this case, the instance variables include the stack height and a Boolean flag used to indicate errors (in the program I use it to indicate that an attempt was made to pop an empty stack; you can also use the flag to indicate an attempt to divide by 0). The methods associated with *TStack* objects initialize, increment, and decrement the stack height.

```
CONST MAX_MENU = 20;

TYPE STRING80 = STRING[80];
     String_Array = ARRAY [0..MAX+MENU] OF STRING80;
     Menu_Range = 0..MAX_MENU;

TMenu = OBJECT
     { declare instance variables }
     Menu_Options : String_Array;
     Num_Options,
     Menu_Choice : Menu_Range;
END;

TItem_Menu = OBJECT(TMenu)
    PROCEDURE Display_Menu;
    FUNCTION Get_Choice : Menu_Range;
END;

TControl_Item_Menu = OBJECT(TMenu);
    Current_Level : Menu_Range;
    PROCEDURE Display_Menu;
    FUNCTION Get_Choice : Menu_Range;
END;

TMain_Pull_Down = OBJECT(TMenu)
    PROCEDURE Display_Menu;
    FUNCTION Get_Choice : Menu_Range;
END;

TPull_Down = OBJECT(TMenu)
    Hot_Key_Char : ARRAY [0.MAX_MENU] OF CHAR;
    Location : ARRAY [0.MAX_MENU] OF INTEGER;
    Attribute : ARRAY [0.MAX_MENU] OF BYTE;
    Active : ARRAY [0.MAX_MENU] OF BOOLEAN;
    PROCEDURE Display_Menu;
    FUNCTION Get_Choice : Menu_Range;
END;
```

Example 1: *Declaration of object types for various kinds of menus*

(continued from page 109)

The second object type, *TRealStack*, is a child of object *TStack*. It defines the stack as a four-element, real-type array. The methods associated with this object type are *Push*, *Pop*, and *Add*. (I've omitted other math-related routines to keep the listing short.) The third type, *THPStack*, is a child of the object type *TRealStack*. This new object type defines the instance variable *LastX* to store the value of the first array element when a stack addition is performed. This also dictates that an overridden *Add* method be defined.

Finally, the fourth object type, *TIntStack*, is a descendant of object *TStack* that implements an integer-type version of object *TRealStack*. The main code portion exercises the methods defined with the objects.

Menus As Objects

Objects find applications in other data structures, such as lists, arrays, and matrices. They can also be applied to data structures representing screens, windows, and menus. Example 1, page 109, shows the declaration for object types representing different kinds of menus.

The *TMenu* object type defines

Object-oriented Pascal limits objects to single inheritance

instance variables that perform the following:

- Tackle the text for menu options.
- Store the number of actual options available.
- Store the number of the option selected (the 0th option is used for exiting from the menu).

TItem_Menu is a menu object type that builds on *TMenu* simply by adding two methods: one to display the menu and another to return the selected choice. The object type *TControl_Item_Menu* is a modified version of *TItem_Menu* that allows you to implement progressive menus that gradually reveal more options. These menus display an itemized menu that contains only the options available to you at the current level.

The *TMain_Pull_Down* object type uses the same instance variables of object type *TMenu*; however, it implements its own version of the methods to display the main menu of a pull-down menu system. The individual options of a pull-down menu are defined by the object type *TPull_Down*. This type declares an additional number of instance variables that are arrays that serve to:

- Define the hot-key characters.
- Locate where the hot-key characters are displayed and their accompanying display attributes.

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TEXAS INSTRUMENTS

261933B

(continued from page 110)

- Define Boolean flags to indicate whether an option is active or passive.

Inheritance Problems

Object-oriented Pascal limits objects to single inheritance: one object type has at most one parent object type. Other languages and implementations, such as Smalltalk, Object Logo, and ExperCommon LISP, support multiple inheritance. I'd like to see multiple inheritance implemented in future versions of object-oriented Pascal because it offers the flexibility and power to model real-world objects realistically. This new level of sophistication generates new problems, though.

Among the first problems to resolve is the question of inheriting instance variables and methods that are present in the ancestor objects. The solution involves assigning influence levels, or priorities, to ancestor objects and providing the ability to override them. I suggest some alternate rules for resolving inheritance conflicts by assigning influence levels as follows:

1. The first ancestor object mentioned is the dominant parent, and all other ancestor objects are of equal importance. In the following example:

TYPE Car = OBJECT(Make, Engine, Body)

the ancestor object *Make* has the greater influence concerning conflicting instance variables and methods and the objects *Engine* and *Body* have the same influence. This syntax assumes that there are no conflicts pending between the last two object types.

2. The order of listing the ancestor objects indicates their influence levels. The following object heading declaration illustrates this syntax:

TYPE Car = OBJECT(Make, Engine, Body)

Here, the *Make* and *Body* object types have the strongest and weakest influences, respectively.

3. The list of ancestor object types is partitioned into two sublists using a special character—say, the bar symbol. The first sublist has its ancestor object types listed in decreasing influence; the second has the rest of the ancestor object types on equal footing. Consider the heading:

TYPE Car = OBJECT(Make, Engine | Body, Doors)

The first sublist contains object types *Make* and *Engine*, and the second sublist contains *Body* and *Doors*. The object type *Make* has the dominant influence, followed by *Engine*. The *Body* and *Doors* object types have an equal influence, which is weaker than that of the first two. This syntax also assumes that there are no conflicts pending between the last two object types.

4. Influence levels are explicitly assigned to all ancestor object types using the syntax <*object type*> = <*unsigned integer constant*>. The integers used need not be in any particular sequence, as shown in the following example:

TYPE Car = OBJECT(Make = 100, Engine = 1, Body = 40)

This object type declaration indicates that the object type *Make* has

the highest influence (by virtue of the number assigned to it and not its position in the list of object types). By contrast, the *Engine* object type is the least influential.

The first and third alternatives contain a common weak point: they may be unable to resolve all the inheritance conflicts. The second and fourth suggested syntaxes are conflict-proof. Nevertheless, you need a mechanism to arbitrate or override inheritance rules explicitly. I suggest using the keyword *FROM* to indicate the parent object type supplying the particular attribute, as shown by the following general syntax:

```
<variable> : data <type> FROM
                    <object type>
<method> FROM <object type>
```

Tracking down inherited variables and methods in multiple inheritance is much more complex than in single inheritance. A single link in the latter is replaced by a complex search graph in multiple inheritance. The increased real time for processing multiple inheritance could be compensated for, however, by using fast CPUs and electronic disks, which would keep the overall compilation time relatively short.

A Final Note

Writing this column for the last few years has been fun, but it has also required a great deal of writing time. Other obligations, including the job of editor of M&T's *Turbo Tech Report*, have made it ncessary for me to pass this column's duties on to another member of the *DDJ* family. Although I will continue to write an occasional article for *DDJ*, this month marks my last Structured Programming column. Thank you for your support, and take care of yourselves.

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(Listing begins on page 66.)

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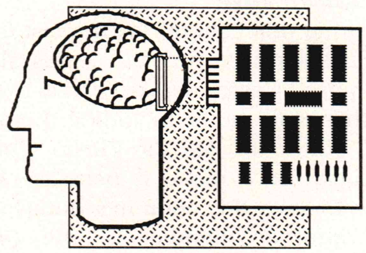
Actor Does More Than Windows



This month I'll be looking at the latest version of The Whitewater Group's object-oriented language Actor. The Whitewater Group has been promoting this language simply as an effective tool for rapid development under Microsoft Windows. It is certainly that. But Actor is also the first object-oriented programming tool specifically designed for writing applications that run under Windows. That fact and The Whitewater Group's intention to port Actor for other windowing systems make it an interesting tool for developing precisely the AI applications that the object-oriented approach is good at while easing the burden of developing for different machines. In this column I'll describe how the latest version (1.1) of Actor implements some of the Microsoft Windows constructs and will examine it from that perspective.

There are so many similarities between Smalltalk and Actor that you may well ask why anyone would develop a new language when implementations of Smalltalk already exist. There are two reasons. First, Actor was designed from the start to be compatible with commercial personal computer environments. Hence its built-in compatibility with Microsoft Windows today and The Whitewater Group's plans to allow window environment programming with Actor across windowing environments tomorrow. Second, the syntax of Actor has been designed to be familiar to C and Pascal programmers. The Whitewater Group's intent was to incorporate all that was good about Smalltalk in a package tailored to the needs of present-day personal computer programmers.

by Ernest R. Tello

To give you a feeling for programming in Actor, I have sprinkled some sample programs through this column as Examples 1 through 4, pages 116, 118, and 125. Three of these are familiar benchmark programs for generating prime and Fibonacci numbers and the Tower of Hanoi and the fourth contains Actor author Chuck Duff's extensions for list processing.

The Actor Desktop

Basically, Actor runs on top of MS-Windows and uses the Windows facilities to implement objects that allow an interactive, windowing environment for development. As with MS-Windows, you can theoretically get along without a mouse, but you wouldn't want to.

The main items used on the Actor desktop are the workspace windows, browsers, and inspectors, which are all modeled on the Smalltalk originals.

When the system first comes up, it shows a workspace window with two rows of command options along the top bar of the window. The commands include *File*, *Edit*, *Doit!*, *Browse!*, *Inspect!*, *Show Room!*, and *Templates*.

The editing area of a workspace window behaves just like an interpreter does. If you type in an expression and then a carriage return, Actor will attempt to compile and execute it. If there is a body of text already in an editing window, then highlighting a portion of that code and clicking on *Doit!* will result in that portion of code being compiled and executed. The *Browse!* and *Inspect!* options result in a new one of these tools opening like a pop-up window on the Actor desktop.

Inspectors are used for focusing on a particular object. You use them to examine the contents of objects in detail as well as to make modifications to them. The upper-left pane of an inspector window contains a list box that displays all the instance variables of an object. Clicking the mouse on any of the items in the scrollable list of variables results in its value being displayed in the bottom pane of the inspector—its edit window. Both class objects and their instances can be accessed using inspectors.

A browser provides a similar function to that of an inspector, but instead of providing an interactive window on a single object, it does this for the entire system of classes. Its scrollable list box contains a list of all the classes currently in the Actor class hierarchy. The right-hand list box contains the methods for the current class. By first selecting a class and then a method in that class, you may access the code in the bottom window and edit it. An Options selection on the browser menu bar allows you to choose whether the classes are listed in hierarchical or alphabetical order.

A Class Act

Actor comes with a large class library of ready-made code that can be used for building applications quickly, once you bridge the learning curve of using the system and knowing what's there. Here is a partial list of the classes used for data structures and the graphics facilities subsumed under them:

```
Object
  Collection
    Indexed Collection
      Array
        Function
        OrderedCollection
          SortedCollection
```

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ARTIFICIAL INTELLIGENCE
(continued from page 114)

```
            TextCollection
        ByteCollection
          String
            Symbol
          Struct
            DosStruct
            GraphicsObject
              Polygon
              Rect
                Ellipse
                RndRect
            Proc
```

Actor Syntax

As with languages such as C and Pascal, Actor encloses arguments to a method in parentheses immediately following the method's name or selector. And like Pascal and Smalltalk, variable assignments are made using the colon-equal (:=) symbol. Also as in Smalltalk, the way you create new instances is by sending the *new* message to a class and assigning this new instance a name. So, for example, you could create an instance of the *Turtle* class by saying:

```
inherit(Object, #Sieve, nil, nil,nil);!!

now(Sieve);!!

/* Returns the number of prime numbers between 0 and cnt,
inclusive. */
Def sieve(self, cnt | flags, count, c)
{       c := cnt + 1;
        flags := new(Array, c);
        fill(flags, true);
        count := 1;
        do( over(2, c),
                { using(i | triple)
                        if flags[i]
                        then triple := i*3;
                                if triple < cnt
                                then  do( overBy(triple-1, c,
i+i-1),
                                  { using(j) flags[j] := nil });
                               endif;
                                count := count + 1;
                        endif;
                });
        ^count;
}!!

Actor[#Sam] := new(Sieve)!!
/* To run type: sieve(Sam, 100) */!!
```

Example 1: *Eratosthenes' Sieve benchmark*

```
now(Int)!!

/* Recursive way of finding the nth Fibonacci term.  Note that
this way of finding the Fibonacci terms is very inefficient
because each message "spawns" two recursive messages.  */

Def fib(self)
{ if self < 3
 then ^1
 endif;  ^fib(self - 1) + fib(self - 2);
}!!

/* Iterative way of finding the nth Fibonacci term. */

Def fib2(self | term, term1Before, term2Before)
{ if self < 3
  then ^1
  else term := 2; term1Before := 1; term2Before := 1;
    do(new(Interval, 3, self + 1, 1),
      {using(i) term := term1Before + term2Before;
       term2Before := term1Before;
       term1Before := term;
      });
    ^term
  endif;
}!!
```

Example 2: *Fibonacci program*

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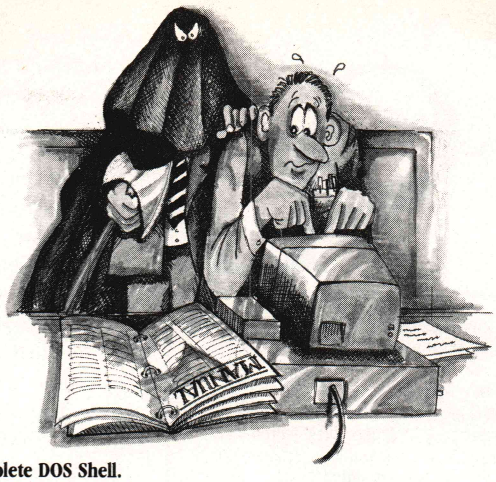

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(continued from page 116)

```
Barney := new(Turtle);
```

In general, sending messages in Actor is like passing arguments but in reverse. The object to which the message is sent is treated as an argument. Once you have created the turtle *Barney*, you can get him to do your bidding by sending various messages that he can recognize. Like any authorized turtle, *Barney* knows that the message *r* means turn right, *l* turn left, *f* move forward, and *b* move backward. He also knows that *down* means to put his tail to the ground for drawing purposes and *up* means to pick it up again.

So, if you wanted *Barney* to perform a turtle walk in the shape of a square, the messages you would send him would be:

```
down(Barney);
f(Barney, 10);
r(Barney, 90);
f(Barney, 10);
r(Barney, 90);
f(Barney, 10);
r(Barney, 90);
f(Barney, 10);
up(Barney);
```

In Actor, the keyword *Def* is used to define methods. So, if you wanted to teach not only *Barney* but also all authorized turtles the new message *walkSquare*, you would define the method:

```
Def walkSquare(self, size)
{ down(self);
  f(self,size);
  r(self, 90);
  f(self, size);
  r(self, 90);
  f(self, size);
  r(self, 90);
  f(self, size);
  up(self);
};
```

Henceforth, to get *Barney* or any of his relatives to perform this maneuver, all you would have to do is to say:

```
walkSquare(Barney, 10);
```

The more astute turtle watchers have probably noticed that this turtle walk is only one orientation for this type of maneuver. There is a species of turtle, admittedly rare, that instinctively will do its square-walking counterclockwise. Fortunately, object-oriented systems such as Actor provide a way of mirroring this little sidelight of natural history. What you can do to cover this complexity is to define a new class of turtle called *CounterTurtle* and provide a *walkSquare* method for turtles

```
/*  ref.  Byte August, 86  p. 146   cbd  8.13.86 */!!

inherit(Object, #TowerOfHanoi, nil, nil, nil);!!

now(TowerOfHanoi);!!

Def moveTower(self, height, from, to, use)
{  if height > 0
   then
     moveTower(self, height - 1, from, use, to);
     moveTower(self, height - 1, use, to, from);
   endif;
}!!

Def moveTower2(self, height, from, to, use)
{  if height > 0
   then
     moveTower(self:TowerOfHanoi, height - 1, from, use, to);
     moveTower(self:TowerOfHanoi, height - 1, use, to, from);
   endif;
}!!

Actor[#Hanoi] := new(TowerOfHanoi);!!

/* Example solves runs the Tower of Hanoi problem */!!
moveTower(Hanoi, 3, 1, 3, 2);!!
```

Example 3: *The Tower of Hanoi*

of this species that does the counterclockwise variant of the standard turtle square walk. Coincidentally, this also provides me with the opportunity of illustrating how new classes are defined in Actor.

The way you usually create new classes in Actor is from within a browser, so I'll do it that way first. Very simply, you first select the class *Turtle* from the class list. Then you go to the Options pull-down menu and select *Make Descendant*. A pop-up window then opens that serves as a template for creating the new class. In this case, let's enter *CounterTurtle* as the name of the class. Now you just click on the Accept button, and the system will create this new class and its name will be added to the class list and become part of the Actor class hierarchy.

The other way to create new classes, which is what the browser is actually doing, is to write the code for it directly. The *inherit* statement is used for this. So, you could write:

```
inherit(Turtle, #CounterTurtle) !!
```

One of the most attractive things about the Actor system is that it provides built-in classes for making the use of the Microsoft Windows user interface easier. Three main classes are concerned with this: *Window*, *Control*, and *ModalDialog*. First let's look at the *Window* class and its descendants. Here is an outline of this branch of the class hierarchy:

```
Object
  Window
      PopupWindow
          ToolWindow
              Browser
              Inspector
      TextWindow
          EditWindow
              WorkEdit
                  BrowEdit
                  FileWindow
                  Workspace
          ScanWindow
          WorkWindow
```

Though relatively large, *Window* is just a formal or abstract class. This means that it implements the methods that will be used by the sub-

(continued from page 119)

classes that implement the specialized windows that actually get instantiated and used. In particular, *Window* implements the routines that communicate with MS-Windows.

The *TextWindow* class is one of the simplest descendants of *Window* that you can get to actually do real things. This class allows you to create tiled windows that can print text. It does this with the *printString* and *printChar* methods, which call the *Textout GDI* (Graphics Display Interface) function in MS-Windows.

Often you will want text windows that can do more that just show text—that can allow you to go in and edit that text. The subclass of *TextWindow* called *EditWindow* provides the code that supports this editing ability. The *WorkEdit* class takes this one step further by allowing you to create windows that can not only edit but can also enter Actor language statements to be evaluated. The three subclasses of *WorkEdit* provide the types of windows that are like those most often used—browsers, file browsers, and general-purpose workspace windows. The main difference, though, is that, like their ancestor *TextWindow*, these are tiled windows.

The windows most often used in Actor come from another branch of the tree that is implemented with the class *PopupWindow*. The windows you get by instantiating *PopupWindow* are the familiar layered windows that stack up on top of one another. Unlike the tiled windows, however, they do not permit you to zoom or contract them down to an icon. As is dictated by MS-Windows, pop-up windows have to have a "parent" text window. When this parent window is contracted into an icon, then the pop-up windows associated with it temporarily become invisible.

Controls and Dialog Boxes

As in MS-Windows, in Actor a control is a special type of window that is used for routine input and output in a user interface. Examples of controls include things like buttons, list boxes, and scroll bars. The branch of the class tree concerned with controls looks like this:

```
Object
   Control
      Button
      ListBox
         ClassList
      Scrollbar
```

Like *Window*, the *Control* class in Actor is just a formal one, and its subclasses are the ones that are actually instantiated in applications. Controls are handled in Actor in an almost identical way to windows. New instances are created by sending the *new* message, and they are displayed by sending the *show* message.

I'll describe one other class—the *ModalDialog* class and its subclasses.

```
Object
   ModalDialog
      ClassDialog
      DebugDialog
      DirtyCLD
      FileDialog
      InputDialog
```

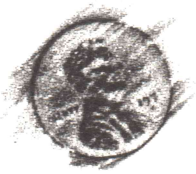
Modal dialog boxes resemble pop-up windows in that they stack on top of other windows and they need a parent window with which they are associated. Like *Window* and *Control*, *ModalDialog* is basically an abstract class that implements code intended for use by its descendants. The *FileDialog* class in Actor is used to create the dialog boxes that routinely appear in MS-Windows when you load a file by using a pull-down menu. The *ClassDialog* class is for dialog objects used when a class is being edited or created with a browser.

Using Actor for AI

For AI applications, as well as many other types of application, processing linked lists is essential. How do you go about doing that in Actor? One way might be to work with the *OrderedCollection* class and add subclasses to it with the necessary methods defined for list processing.

Example 4, a demo provided with the current release of Actor, offers another approach, however. The new class *ListNode* is defined as a subclass of the *Collection* class. The

Remember,



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15	40	65	90	115	140	165	190	215	240	265	290	315	340	365	390
16	41	66	91	116	141	166	191	216	241	266	291	316	341	366	391
17	42	67	92	117	142	167	192	217	242	267	292	317	342	367	392
18	43	68	93	118	143	168	193	218	243	268	293	318	343	368	393
19	44	69	94	119	144	169	194	219	244	269	294	319	344	369	394
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21	46	71	96	121	146	171	196	221	246	271	296	321	346	371	396
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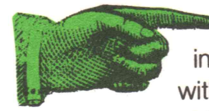

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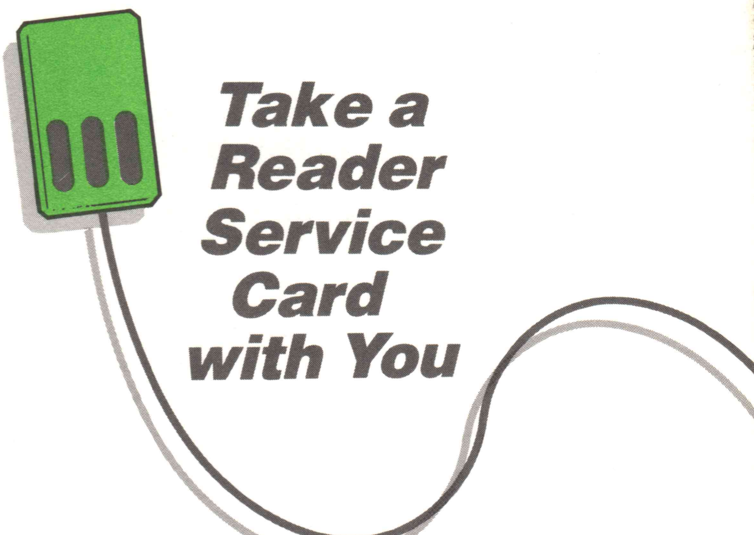

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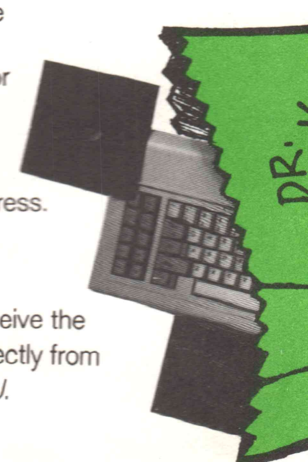

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methods *append, do, isAtom, printOn,* and *rPrintOn* are defined for this new class. New methods, including *isAtom, rPrintOn,* and *cons,* are also defined for the root class, *Object*. If you inspect the code for *cons,* you will see that there is a routine for sending the message *new* to the *ListNode* class and creating a new instance of it. Obviously, this is only the rudimentary beginning of what a functional list-processing class would encompass.

As far as the suitability of Actor for AI applications is concerned, the same limitations that apply to Smalltalk apply here. As compared with LISP and PROLOG, Smalltalk and Actor are relatively low-level languages. They are suitable for developing AI applications, but many additional high-level methods and classes have to be written from scratch just to get started.

The structures used by the *OrderedCollection* class differ significantly from dynamically modifiable linked lists. In the terminology of object-oriented programming, ordered collections are fixed collections that are nevertheless "growable." This means that when you create an *OrderedCollection,* you must create one with a maximum number of elements. If the elements already stored in the collection have not yet reached the maximum, it is easy to add new elements to the beginning or end of the list. When the maximum is reached, and you need more, you must send the *grow* message to the collection. What really happens when you do this is that a new array of the needed size is created and the elements of the old array are copied into it.

Debugging

With Version 1.1 a new debugger has been added to Actor. Currently, both a low-level and high-level debugger are provided, but the low-level debugger is not formally supported and may disappear in later releases of the Actor system.

Routine errors in code evaluated by Actor result in a dialog box that contains a stack history up to the point of the error. The dialog box usually also contains a message that diagnoses the type of error. If you wish, when a dialog box is open because of an error, you can click on the Debug button and cause a Debug window to open.

This is a versatile debugging tool that combines some of the features of a browser and some of those of an inspector as well as the ability to change any of the values associated with a method. With it you can also resume processing on the fly immediately after an error has been fixed.

Conclusions

On the whole, I find Actor to be a thorough implementation of a full programming system with an excellent set of demo programs and helpfully written documentation and tutorials. The ideal users of Actor, as I see it, would be programmers who have already had some exposure to Smalltalk and need to prototype something quickly to run in the MS-Windows environment. For purposes such as these, it is hard to beat.

One thing about the implementation of Actor I dislike, though, is the absence of a facility for multiple inheritance. With systems intended for real-world applications, multiple inheritance should be a standard feature because in the real world many things fulfill multiple roles and multiple functions. Multiple inheritance provides a ready way of handling this in an explicit way.

Vendors of object-oriented tools who fail to include multiple inheritance typically say that they do not want to make the system too complex for users or that none of their customers have requested it. I have not found either of these explanations at all convincing. I have had no difficulty in using multiple inheritance in systems that have it and can't imagine trying to build a serious object-oriented application without it.

In response to this, it might be said that you can still create classes of the same definition in a system without multiple inheritance the hard way simply by defining them to be exactly what you want. My feeling about this is that it may be true in theory but it tends to be something that is never done in prac-

ARTIFICIAL INTELLIGENCE
(continued from page 122)

tice. In the two years or so that I have worked with object-oriented programming systems, I have never done this unless the system provided for multiple inheritance, in which case it becomes a routine practice.

The reason is the same one that makes interactive systems such as Actor significant and not just a mere convenience. The more you make basic things easy to do, the more you tend to launch out into the more difficult areas creatively, trying things that otherwise you might not have tried. If you are a user of an object-oriented programming tool that lacks this feature, I strongly recommend that you pester the vendor to put it at the top of the list for new features. I feel almost certain that you will not regret the results of having exercised your prerogative as a customer.

Version 1.1 of Actor differs from 1.0 in two main ways. First of all, there is more space—an additional 70K—for compiling applications. Second, it is fully compatible with Windows II, though it does not fully support all of Windows II's facilities. A future release of Actor, though, will actually support programming with the new features of Windows II. Needless to say, the implementations of Actor that will use the full features of Windows II and the OS/2 Presentation Manager will ultimately determine the fate of this product. But if the current implementation is any indication, the future versions should be of very high quality indeed.

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now(NilClass);!!
/*  append nil to a node  */
Def append(self, aNode)
{ ^aNode }!!

Def cons(self, aNode)
{ ^aNode }!!

Def rPrintOn(self, aStrm)
{ printOn('[', aStrm);
}!!

inherit(Collection, #ListNode, #(left right), nil,nil);!!

now(ListNode);!!

Def append(self, aNode)
{ ^cons( left, append(right, aNode));
}!!

Def do(self, aBlock)
{ if isAtom(left)
 then eval(aBlock, left);
 else do(left, aBlock);
 endif;
 if right
 then do(right, aBlock);
 endif;
}!!

Def isAtom(self)
{ ^nil }!!

Def printOn(self, aStrm)
{ printOn('[', aStrm);
 printOn(left, aStrm);
 rPrintOn(right, aStrm);
}!!

Def rPrintOn(self, aStrm)
{ printOn(' ', aStrm);  printOn(left, aStrm);
 rPrintOn(right, aStrm);
 printOn(']', aStrm);
}!!

now(Object);!!

Def isAtom(self)
{ }!!

Def rPrintOn(self, aStrm)
{ printOn('.', aStrm);
 printOn(' ', aStrm);
 printOn(self, aStrm);
 printOn(']', aStrm);
}!!

Def cons(self, aNode | newNode)
{ if isAtom(aNode)
 then newNode := new(ListNode);
 else newNode := copy(aNode);
 endif;
 newNode.left := self;
 newNode.right := aNode;
 ^newNode;
}!!
```

Example 4: *List-handling support in Actor*

(continued from page 12)

is a defining word *UNITS*:

```
: UNITS CREATE SWAP , , DOES>
                         D@ */;
```

Then you would have what appears in Example 1, page 12. This is an improvement, but Forth permits a simple addition that allows conversion back to the input units when outputting (see Example 2, page 12).

Obvious modifications include use of floating point (to prevent the unintentional truncations of integer arithmetic) and defining a machine-code sequence *<DO-UNITS>* to replace the run-time instructions following *DOES>* if greater speed is needed. (It probably isn't—these definitions are intended to I/O a relatively small set of measurements from the console or a file.)

Finally, let me put in a plug for HS/FORTH (for IBM PCs/clones): Jim Callahan's Harvard Softworks (P.O. Box 69, Springfield, OH 45066) has been extremely supportive with upgrades, fixes, technical advice, and so on. The version of Forth is extremely fast "as is" but comes with all sorts of goodies and tools for using the 8087 chip, string handling, windowing, graphics, sound, and so on. Although the documentation of several years ago was rather cryptic, it is now excellent and includes Kelly and Spies' textbook. I have never seen this product reviewed or mentioned and cannot imagine why, considering its excellence.

Julian V. Noble
105 Powhatan Cir.
Charlottesville, VA 22901

Instruction Timings

Dear *DDJ*,

I hate to be the bearer of bad news, but Tom Disque's "8088 Assembly-Language Programming Techniques" in the July 1987 issue is inaccurate. In several cases Disque presents instruction timings that are not consistent with his assumptions.

In the second paragraph, Disque says, "Please note that all timings are for the 8088 microprocessor and assume that the 4-byte 8088 prefetch queue is empty at the start of execution." Although this is a good assumption because the 8088 is so common and the prefetch queue is always empty except for a few relatively rare circumstances, the timings that Disque gives for his instruction sequences do not correspond to this statement.

Disque claims that the simple sequence:

```
mov ax, cs
mov es, ax
```

takes four cycles to execute. If the prefetch queue is empty, however, the instructions must be fetched first. These two instructions are 4 bytes, and the 8088 requires four clock cycles per memory cycle. This alone comes to 4×4, or 16 clock cycles, just to fetch the instructions, never mind any additional execution time. If the prefetch queue were full, you would have a different story, but Disque assumed that it wasn't.

I suspect that Disque probably meant to do better than this because later he gives the example:

```
shl ax, 1
shl ax, 1
shl ax, 1
shl ax, 1
```

He says: "Faster (8 cycles [plus 8 more to fetch the two extra instructions] . . . ." I'm not sure what to make of this. Either he meant to assume the prefetch queue was empty or that it was full. In any case, it would take 16 clock cycles to fetch two instructions, not 8 (4 clock cycles per byte times 2 bytes per instruction times 2 instructions).

Let's examine how the 8088 really executes the previous sequence. First, it must fetch the first instruction—eight clocks. It then starts fetching the second instruction while processing the first one. Processing the instruction takes two clocks and fetching the second instruction takes eight. Because eight is more than two, you really have to wait eight clock cycles. At this point the cycle repeats. The total "execution" time is 32 clock cycles.

As you can see, it takes the 8088

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Dallas, Texas 75248

(continued from page 126)

much longer to fetch its instructions than to execute them, so the 8088's speed is proportional to the number of bytes it must transfer. This includes instruction bytes as well as data processed by a program. This also means that the 8088's 4-byte queue is almost always empty.

The few exceptions are multiply and divide instructions, which take longer to execute than to fetch. There are also a few esoteric instructions that take longer to execute than to fetch, but their use is so rare that you can forget about them.

Therefore, to time 8088 code that does not include multiply or divide instructions, all you have to do is add the number of bytes of instruction that must be fetched to the number of bytes of data transferred in memory. Once you have the total number of reads and writes to memory, you multiply by four clocks per fetch. You need no instruction timing tables or photographic memory. All you need to be able to do is count and multiply by 4 (two left shifts in binary).

This same concept is used to time Z80 code, except for one quirk. The Z80 takes four clocks for the first byte of an instruction fetch and three clocks to fetch the data.

What about the 8086? The 8086 can fetch instructions faster than the 8088 can but is still basically limited to how fast it can fetch instructions (and read/write to memory). The 80386 should finally provide enough memory width (32 bits) to make a prefetch queue worthwhile.

Disque redeems himself, however, with his Example 8, which demonstrates an excellent, fast, general-purpose, memory move routine. The correction for odd address transfers shows good understanding of that aspect of the 8086 processor.

Good assembly-language programmers such as Disque are rare, but sometimes we all become victims of Intel's overly optimistic instruction timings. Disque's instruction timings sound like they came from Intel.

Lee Pelletier
5 Burley St.
Wenham, MA 01984

Correction

Dear *DDJ*,

I'd like to provide some additional information about the Async AppleTalk article published in the October 1987 issue of *DDJ*.

Async AppleTalk is based on the source code of Apple Computer's AppleTalk driver. The following notice was dropped from the article during the editing process: The AppleTalk protocols and computer programs are licensed from Apple Computer Inc. and AppleTalk, Macintosh, and LaserWriter are trademarks of Apple Computer Inc. Portions copyright (c) 1985 Apple Computer and copyright (c) 1987 the Trustees of Dartmouth College.

Also, the disk being distributed by *DDJ* does not contain the executable desk accessory. This, along with the source files and other debugging

tools, is available from the authors. Please send a blank (800K) Macintosh disk in a mailer to me at the address listed below.

Richard Brown
Dartmouth College
Async AppleTalk Distribution
Kiewit Computer Center
Hanover, NH 03755

Stonecutter Error

Dear *DDJ*,

With reference to the cover of your September 1987 issue, the statement *TAKAGUCK* will never be executed because *ZOK-OOT-UK* always sets *GLOOTBLEE* false. The correct statement should be *XOK-OOT-OK*, which uses *GLOOTBLEE* as an error indicator. Please inform your stonecutter to proofread the algorithms before printing.

James Sturdevant
Minneapolis, MN

To List or Not to List

Dear *DDJ*,

In response to your question about source listings in Running Light (November 1987), I personally feel a big value in *DDJ* is the source listings. I use them and I'm sure a lot of the silent majority do too. You're right about a typing drill, so I normally try to download instead to typing. I agree with posting them on CompuServe, and maybe the idea of a BBS run by *DDJ* would be a good addition. Most of the bigger PC publications have established one for their readers.

One different idea I would like to push is the use of Cauzin Softstrips from Cauzin Systems ([203] 573-0150) in each publication, like *PC Magazine* does. Cauzin readers are cheap ($200) and will pay for themselves to readers like me who are far removed from California. I thought you were using Softstrips at one time, and I'm not sure what happened. Anyway, it is a cheap alternative for avid software users like me.

I hope you will consider my suggestion. It would sure be a help to a lot of us.

David Doss
Computer Science Dept.
Illinois State University
133 B Stevenson Hall
Normal, IL 61761

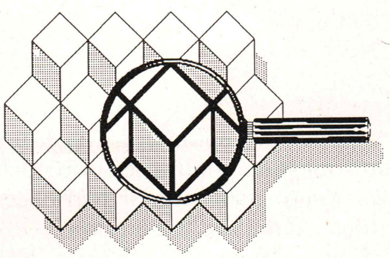
Dear *DDJ*,

I have a few comments regarding your question about the source listings. Keep small (one or two pages) listings. Put long listings on a BBS and make them available on disk. CompuServe is no solution. *PC Magazine*, *Byte*, and *Computer Language* all have great BBSs for downloading. Also, make sure all necessary *include* files are present for C programs. Most published C source code is useless because the author uses routines hidden in header files that are not provided.

Edgar T. Lynk 2G
70 Park Terrace East
New York, NY 10034

DDJ

OF INTEREST



Language Products for the Mac

Two new versions of LPA MacPROLOG are available from **Logic Programming Associates**: the Student Edition uses a built-in incremental compiler and a high-powered declarative graphics environment; the Wizard Edition also has a built-in incremental compiler and high-powered declarative graphics environment along with a new C and Pascal interface, serial I/O, and an optimizing compiler. Both versions require 1 megabyte of memory. The Student Edition costs $275, and the Wizard Edition costs $495. Reader Service No. 16.

Logic Programming Associates
Studio 4
The Royal Victoria Patriotic Building
Trinity Rd.
London SW18 3SX
England
01-8711-2016

Version 2.0 of True BASIC, a language system for the Macintosh and the Macintosh II developed by **True BASIC Inc.**, is now shipping. True BASIC 2.0 offers several new features, including enhancements to the editor; new debugging tools; enhanced speed; and modules, a programming concept found in Modula-2 and Ada. True BASIC supports color graphics for the Mac II as well as the 68881 math coprocessor. Programs written in True BASIC on the Mac can also run on the IBM PC, Amiga, and Atari ST. The retail price of True BASIC 2.0 is $99.95. Owners of previous versions can upgrade to the new version at a cost based on a sliding scale, depending on the date of original purchase. Reader Service No. 17.

True BASIC Inc.
39 South Main St.
Hanover, NH 03755
(604) 643-3882

TurboGeometry Library, a new software tool for Macintosh programmers who write graphics, engineering, educational, and other programs that use geometry, has been released by **Disk Software**. The library comes with source code for more than 150 routines, including routines that find the intersection of lines, polygons, arcs, and planes; determine the coefficients of the equations of lines, circles, arcs, and planes; convert the coefficients of one equation to another; find the distance between points, lines, circles, arcs, and planes; decompose a concave polygon into a series of convex polygons; and more. The library sells for $99.95. Reader Service No. 18.

Disk Software Inc.
2116 East Arapaho, Ste. 487
Richardson, TX 75081
(214) 423-7288

Mac AI

ExperTelligence is now shipping two AI products for the Macintosh: ExperCommonOPS5 and ExperCommon LISP Foreign Function Interface.

Some of the features of ExperCommonOPS5 include a forward-chaining, rule-based, expert system language; a custom tracing mechanism of rule firings and changes to memory; the ability to pause, examine memory, and undo rule firings to revert to an earlier state; conformation to the de facto OPS5 standard described in *Programming Expert Systems Using OPS5* (Brownston et al., Addison-Wesley); complete portability to other implementations of OPS5; facilities to interface with other programming languages and tools; the ability to create complex Macintosh user interfaces for developed expert systems; and integration with the most powerful AI development environments available today. ExperCommonOPS5 runs in both ExperCommon LISP for the Macintosh Plus and SE and ExperCommon LISP II for the Macintosh II, Version 2.2 or later. The retail price is $595.

The ExperCommon LISP Foreign Function Interface is an add-on component of the complete ExperProfessional Development System. Users can create a new version of the ExperCommon LISP language that contains functions written in any Macintosh Programmer's Workshop language: C, Pascal, or assembly language. Once the new version has been created, the foreign functions can be called from ExperCommon LISP in the same way as any other built-in function. The Foreign Function Interface runs in ExperCommon LISP on the Macintosh Plus and the Macintosh SE and runs on the Macintosh II with ExperCommon LISP II. The price is $295. Reader Service No. 19.

ExperTelligence Inc.
559 San Ysidro Rd.
Santa Barbara, CA 93108
(805) 969-7874

Human Intellect Systems has announced Instant-Expert Plus, a Macintosh expert system shell. Instant-Expert Plus uses natural-language rule entry, interactive graphics, variables, and more than 18 different inference engine search strategies. Hardware requirements are a Macintosh 512K with an external drive. Instant-Expert Plus retails for $498. Reader Service No. 20.

Human Intellect Systems
1670 S. Amphlett Blvd., Ste. 326
San Mateo, CA 94402
(415) 571-5939

For the Atari ST and Amiga

A new version of the Metacomco Toolkit is now available from **Metacomco**. The toolkit consists of 11 useful AmigaDOS commands that are stored in the C directory and can be used in the same way as the standard DOS commands. The new version also includes a Unix-based make utility and a touch utility. Commands included in the package are Pipes, Librarian, Disassembler, Auxil-

iary CLI, Mount, Browse, Enlarge, Pack, Unpack, Make, and Touch. Metacomco Toolkit 1.2 works under Versions 1.1 and 1.2 of AmigaDOS and can augment the Metacomco shell. The price for the package is $49.95. Reader Service No. 21.
Metacomco
26 Portland Sq.
Bristol BS2 8RZ
England
44-272-438781

FTL Modula-2 for the Atari ST from **Workman & Associates** is now shipping. The Atari version is fully compatible with existing FTL programs and includes a complete GEM interface. The package sells for $79.95. Reader Service No. 22.
Workman & Associates
1925 East Mountain St.
Pasadena, CA 91104
(818) 791-7979

Miscellaneous

MEMOCOM is now shipping a universal cross-development kit for the Macintosh that includes a table-driven cross-assembler and a MEMULATOR II or MEMULATOR 16 in-circuit EPROM emulator. With the kit, developers can use the Macintosh to assemble and test sources programs for virtually any microprocessor/controller with 24 or less address bits. Both the universal cross-assembler and MEMULATOR II/16 support industry-standard Intel hex, Motorola S-record, and straight binary formats. These output file formats are compatible with most serial EPROM programs. The MAC Universal Cross-Development Kit sells for $725 with a MEMULATOR II and $1,275 with a MEMULATOR 16. The kit is also available for PC-DOS and MS-DOS systems and the Atari ST. Reader Service No. 23.
MEMOCOM
1920 Arbor Creek Dr.
Carrollton, TX 75010
(214) 446-9906

Addison-Wesley has released the Programmer's Online Companion by Steven Capps, a disk-based database reference to *Inside Macintosh*, Volumes 1–4, and the *Apple Numerics Manual*. The companion is a utility program that allows programmers immediate access to bits of information from within any language development system and includes almost all the system calls, system globals, and assembly-language equates found in those volumes. The program controller resides in 5K RAM. The structure assumes a basic knowledge of Pascal or assembly language, *Inside Macintosh*, and the Macintosh itself. The package includes a 3.5-inch disk and 32 pages of documentation. It runs on the Macintosh 128K, Macintosh 512K, Macintosh 512Ke, and Macintosh Plus and sells for $34.95. Reader Service No. 24.
Addison-Wesley Publishing Co.
Rte. 128
Reading, MA 01867
(617) 944-3700

Whitesmiths has announced CXDB, an interactive C source-level cross-debugger for the Motorola MC680x0 line of processors. CXDB is a host-resident debugger available for the VAX and IBM PC that allows embedded 68K programs to be debugged in terms of the original C source

(continued from page 131)

code. Features allow users to execute host system commands; print the contents of a C variable function or file with or without assembly-language display; step through single or multiple lines until a specific location is reached, again with or without assembly-language display; create log output for later examination; set and remove breakpoints on a specific C variable, line, or function; disassemble C source lines; obtain in-line help; display stack frames with or without type; and value information for variables in each frame. Prices for CXDB range from $1,800 to $7,000. Reader Service No. 25.
Whitesmiths Ltd.
59 Power Rd.
Westford, MA 01886
(617) 692-7800

Optotech has introduced Laser DataBank, a "plug-and-play" 5¼-inch write-once read-many (WORM) optical drive subsystem for four popular computer environments: Sun Microsystems' Sun-3; DEC's MicroVAX II; IBM's PC, PC/XT, and 286/386-based computers, including the PS/2 and compatibles; and Apple's Macintosh SE and Macintosh II. The proprietary software also allows data exchange among all four subsystems by writing disks that can be read by any Optotech drive. All the subsystems are built around the Optotech Model 5984 Optical Disk Drive with 400 megabytes of storage per 5¼-inch optical disk drive. Proprietary interface software in each subsystem makes the write-once drive immediately compatible with the host computer's operating system and provides standard file and disk management functions.

The price for the Macintosh Laser DataBank is $3,995. Single-unit prices for the Sun and VAX are $5,950 and $6,950, respectively. The Laser DataBank for PCs is currently available at a single-unit price of $2,995. Reader Service No. 26.
Optotech Inc.
740–770 Wooten Rd.
Colorado Springs, CO 80915-3518
(303) 570-7500

Reduce, from **Northwest Computer Algorithms**, is an interactive software system designed for general mathematical computations of interest to scientists, mathematicians, engineers, and university students. The system has been applied to a variety of problems in many different research areas, including quantum electrodynamics, quantum chromodynamics, electrical network analysis, plasma physics, celestial mechanics, general relativity, numerical analysis, and a variety of engineering problems such as turbine and ship hull design. The code is portable across a wide range of machines. Reduce is now available for the following machines: VAX; Sun; Apollo; Macintosh; and IBM PC, PC/XT, PC/AT, and compatibles. A single-machine license costs $495. Reader Service No. 27.
Northwest Computer Algorithms
P.O. Box 1747
Novato, CA 94948
(415) 897-1302

DDJ

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Supports all commercial grade C compilers. Requires 128K memory. Version 4.1F.

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Specify compiler (current version): Borland Turbo C, Lattice C, or Microsoft C. Requires 128K memory. Version 1.0.

SoftCraft

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List $595 Reg $454 **Sale $429**

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ai - lisp language

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Screen Design Toolkit	50	44
SQL Development Package	295	229
Arity PROLOG Interpreter	295	229
Arity Standard Prolog	95	77
LPA microPROLOG *All Varieties*	CALL	CALL
MPROLOG Language Primer *LOGICWARE*	50	45
MPROLOG P500 *by LOGICWARE*	495	395
MPROLOG P550 *w/Primer by LOGICWARE*	220	175
Turbo PROLOG *by Borland Intl*	100	64
Turbo PROLOG Toolbox *by Borland Intl*	100	64

ai - smalltalk language

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EGA/VGA Color Option	50	45
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Smalltalk/Comm	50	45

ai - texas instruments

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Arborist *Decision Tree Software*	595	519
PC Scheme *Lisp*	95	77
Personal Consultant Easy	495	435
Personal Consultant Image	495	435
Personal Consultant Online	995	869
Personal Consultant Plus	2950	2589
Personal Consultant Runtime	95	84

ada language

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AdaVantage *GSA-validated by Meridian Software*	795	735
AdaVantage Utility Packages	50	47
DOS Environment Package	50	47
Ada *GSA-validated w/maintenance by alsys* *New*	3355	3119
Janus/ADA C Pak *by R&R Software*	95	84

apl language

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APL*PLUS PS/2 *by STSC*	695	495
ATLAS*GRAPHICS *by STSC*	450	329
Financial/Statistical Library *by STSC*	275	189
Pocket APL *by STSC*	95	69
STATGRAPHICS *by STSC*	895	649

assembly language

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8088 Assembler *w/Z-80 Translator by 2500 AD*	100	89
ASMLIB *Function Library by BCSoft*	149	125
asmTREE *B-Tree Dev System by BCSoft*	395	329
Cross Assemblers *Various by 2500 AD*	CALL	CALL
EZASM *by C Source*	70	59
Microsoft Macro Assembler	150	CALL
Resident-ASM *by American Software Intl* *New*	150	139
Turbo Debugger *by Speedware*	89	79
Turbo Editasm *by Speedware*	99	84
Visible Computer: 8088 *by Software Masters*	80	64

basic language

	List	Ours
db/Lib *for QuickBASIC by AJS Publishing*	139	119
Finally *by Komputerwerk*	99	85
MACH 2 *by Micro Help*	69	55
Microsoft QuickBASIC *New Version*	99	CALL
QBase *Relational Database by Crescent*	89	79
Quick-Tools *by BCSoft*	130	109
QuickPak *by Crescent Software*	69	59
Scientific Subroutine Library *by Wiley*	125	99
Screen Sculptor *by Software Bottling*	125	91
Stay-Res *by MicroHelp*	69	55
True BASIC	100	79
True BASIC *w/Run-time* *Special Price*	150	99
True BASIC 3D Graphics	50	41
True BASIC Developer's Toolkit	50	41
Turbo BASIC Compiler *by Borland Intl*	100	64

blaise products

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C TOOLS PLUS/5.0	129	99
KeyPlayer *Super Batch Program*	50	45
LIGHT TOOLS *for Datalight C*	100	65
PASCAL TOOLS & TOOLS 2	175	135
RUNOFF *Text Formatter*	50	45
TURBO ASYNCH PLUS	129	99
TURBO C TOOLS	129	99
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VIEW MANAGER *Specify C or Pascal*	275	199

borland products

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Turbo Basic Compiler	100	64
Turbo Basic Database Toolbox	100	64
Turbo Basic Editor Toolbox	100	64
Turbo Basic Telecom Toolbox	100	64
Turbo C Compiler *(Call for support products)*	100	64
Turbo Lightning and Word Wizard	150	94
Turbo Lightning	100	64
Turbo Lightning Word Wizard	70	47
Turbo Pascal	100	64
Turbo Pascal Database Toolbox	100	64
Turbo Pascal Developer's Toolkit	395	289
Turbo Pascal Editor Toolbox	100	64
Turbo Pascal Gameworks Toolbox	100	64
Turbo Pascal Graphix Toolbox	100	64
Turbo Pascal Numerical Methods Toolbox	100	64
Turbo Pascal Tutor	70	41
Turbo Prolog Compiler	100	64
Turbo Prolog Toolbox	100	64

c language

	List	Ours
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C Trainer *with Book by Catalytix*	122	87
DeSmet C *w/Debugger & Large case*	209	184
DeSmet C *w/Debugger only*	159	138
Eco-C88 Modeling Compiler *by Ecosoft* *New*	100	79
Instant C *by Rational Systems*	495	369
Lattice C Compiler *vers. 3.2 from Lattice*	500	265
Mark Williams Let's C *with FREE csd*	75	54
Microsoft C Compiler 5.0 w/CodeView	450	CALL
Microsoft QuickC Compiler	99	CALL
Optimum-C *by Datalight*	139	95
Turbo C Compiler *by Borland*	100	64
Uniware 68000/10/20 Cross Compiler *by SDS*	995	829

c utilities

	List	Ours
Blackstar C Library *by Sterling Castle*	125	98
C++ *by Guidelines w/version 1.1 kernel*	195	172
c-tree & r-tree Combo *by FairCom*	650	499
c-tree *ISAM File Manager*	395	289
r-tree *Report Generator*	295	239
Csharp Realtime Toolkit *by Systems Guild*	600	489
Curses Window Dev Pkg *by Aspen Scientific*	119	105
with Source Code	289	249
dBx *dBASE to C Translator by Desktop AI*	350	299
with Source Code	550	419
Entelekon Combo Package *Special Price*	200	125
Flash-up Windows *by Software Bottling*	90	78
GraphiC *Color version by Sci Endeavors*	350	274
HALO *Graphics by Media Cybernetics*	300	205
HALO Development Pkg *for Microsoft*	595	389
The HAMMER *by OES Systems*	195	129
HOOPS *3-D Graphics by Ithaca Software* *New*	575	459
LINK&LOCATE *by Systems & Software* *New*	350	309
PANEL/TC *for Turbo C by Roundhill*	129	95
PANEL Plus *by Roundhill*	495	395
PC Lint *by Gimpel Software*	139	99
Resident-C *by American Software Intl* *New*	150	139
RTC PLUS *Fortran to C by Cobalt Blue*	450	369
Sapiens V8 *Virtual Memory Manager*	300	265
Scientific Subroutine Library *by Wiley*	175	135
TE Developer's Kit *by Sub Systems*	95	85
Vitamin C *by Creative Programming*	225	149
VC Screen *Forms Designer*	100	79
WKS LIBRARY *by Tenon Software* *New*	89	79
Zview *by Data Mgmt Consultants*	245	119

cobol language

	List	Ours
COBOL spII *by Flexus*	395	329
FPLIB *for Realia COBOL by BCSoft*	149	129
Micro Focus COBOL *See Micro Focus Section*		
Microsoft COBOL *See Microsoft Section*		
Realia COBOL with RealMENU	1145	899
Realia COBOL	995	783
RealCICS	995	783
RM/COBOL *by Ryan-McFarland*	950	CALL
RM/COBOL 85 *by Ryan-McFarland*	1250	CALL
RM/NET+5 *by Ryan-McFarland*	300	CALL
RM/Screens	395	CALL
SCREENIO *by Norcom*	400	379
screenplay *for COBOL by Flexus*	175	115

database management

	List	Ours
Advanced DBMaster *by Macon Software* *New*	510	419
Clipper *by Nantucket* *New*	695	CALL
dBASE III Plus *by Ashton-Tate* *New*	695	389
dbIII Compiler *by WordTech Systems* *New*	CALL	CALL
dbSQL *by WordTech Systems* *New*	CALL	CALL
dbxl *by WordTech Systems* *New*	169	109
dFLOW *by Wallsoft* *New*	149	119
The Documenter *by Wallsoft* *New*	295	239
Fox Base Plus *New*	395	249
Genifer *by Bytel* *New*	395	275
MAGIC PC *by AKER* *Special Price, New*	199	179
Paradox 1.1 *by Ansa/Borland* *New*	495	359
Paradox 2.0 *by Ansa/Borland* *New*	725	525
Paradox Network Pack *by Ansa/Borland* *New*	995	725
Q&A *by Symantec* *New*	349	219
Quickcode *by Fox & Geller* *New*	295	179
Quickindex *by Fox & Geller* *New*	149	95
Quickreport *by Fox & Geller* *New*	295	179
QuickSilver *by WordTech Systems* *New*	599	349
R:Base 5000 *by Microrim* *New*	495	CALL
R:Base System V *by Microrim* *New*	700	CALL
\rdb *by Robinson-Shafer-Wright* *New*	139	119
Advanced Revelation *by COSMOS* *New*	950	CALL
SQL Base *by Gupta Technologies* *New*	995	CALL
Multi-User Version *New*	1995	CALL
Tom Rettig's Library *by Tom Rettig & Assoc* *New*	100	79
UI Programmer *by Wallsoft* *New*	295	239
VP-INFO *by Paperback Software* *New*	125	79
VP-PLANNER *by Paperback Software* *New*	100	63
VP-PLANNER PLUS *by Paperback Software* *New*	125	79
XDB II *by Software Systems Technology* *New*	395	CALL
C Programming Interface *New*	295	CALL

debuggers & profilers

	List	Ours
386 DEBUG *Cross Debugger by Phar Lap*	195	129
Advanced Trace-86 *by Morgan Computing*	175	115
Codesmith-86 *by Visual Age*	145	98
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MiniProbe *by Atron*	395	369
Periscope I *with Board by Periscope*	345	275
Periscope II *with NMI Breakout Switch*	175	139
Periscope II-X *Software only*	145	105
Periscope III *8 MHz version*	995	795
Periscope III *10 MHz version*	1095	875
The PROFILER *with Source Code by DWB*	125	89
TURBOsmith *Source debugger for Turbo Pascal*	99	69
The WATCHER *Profiler by Stony Brook*	60	51

disk utilities

	List	Ours
Back-It *by Gazelle Systems*	130	115
Disk Optimizer *by Softlogic Systems*	60	55
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FASTBACK PLUS *by 5th Generation Systems* *New*	189	139
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Vfeature *by Golden Bow Systems*	80	74
Vfeature Deluxe *by Golden Bow Systems*	120	111
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dos utilities

	List	Ours
Advanced Norton Utilities	150	89
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Desqview *from Quarterdeck*	130	115
FANSI-CONSOLE *by Hersey Micro*	75	62
Mace Utilities *Paul Mace Software*	99	89
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Norton Commander *by Peter Norton*	75	55
Norton Utilities *by Peter Norton*	100	59
OPAL *Shell Language by Software Factory*	99	89
Q-DOS II *by Gazelle Systems*	70	59
Taskview *by Sunny Hill Software*	80	55

essential products

	List	Ours
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Essential Communications	185	125
Essential Communications *with Break Out*	250	189
Essential Graphics	250	183
/*residentC*/ *New*	99	85
with Source Code *New*	198	169
ScreenStar *New*	99	85
with Library Source Code *New*	198	169

forth language

	List	Ours
CFORTH *Native Code Compiler by LMI*	300	229
FORTH/83 Metacompiler *Specify Target*	750	599
MMS Forth *by Miller Microcomputer Svcs* *New*	180	159
PC/FORTH *by Laboratory Microsystems*	150	109
PC/FORTH+ *by Laboratory Microsystems*	250	199
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Programmer's Package #2 *by LMI*	350	279
Programmer's Package #3 *by LMI*	500	399
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UR/FORTH Libraries	500	395

fortran language

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50 MORE: FORTRAN *by Peerless Scientific*	125	95
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AUTOMATED PROGRAMMER *by KGK Automated*	995	949
Essential Graphics *by Essential Software*	250	183
Forlib-Plus *by Alpha Computer Service*	70	44
FORTRAN Addenda *by Impulse Engr*	165	138
HALO *Graphics by Media Cybernetics*	300	205
I/O PRO *w/No Limit Library by MEF*	250	219
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Grafmatic	135	117
Plotmatic	135	117
Microsoft FORTRAN *w/CodeView*	450	CALL
No Limit Library *by MEF Environmental*	129	109
Numerical Analyst *by MAGUS*	295	199
PANEL *by Roundhill Computer Systems*	295	199
RM/FORTRAN *by Ryan-McFarland*	599	399
Scientific Subroutine Library *by Wiley*	175	135
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STATLIB.GL: *by Wiley*	295	239
STATLIB.TSF: *by Wiley*	295	239
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greenleaf products

	List	Ours
Greenleaf C Sampler *Specify QuickC or Turbo C*	95	69
Greenleaf Comm Library	185	125
Greenleaf Data Windows Library	225	155
with Source Code	395	249
Greenleaf Functions	185	125

help utilities

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HELP/Control *by MDS*	125	99
On-line Help *from Opt-Tech*	149	99
SoftScreen/HELP *by Dialectic Systems*	195	149

lattice products

	List	Ours
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with Library Source Code	900	495
C Cross Reference Generator	50	37
with Source Code	200	139
C-Food Smorgasbord *Function Library*	150	95
with Source Code	300	179
C-Sprite *Source Level Debugger*	175	CALL
Curses *Screen Manager*	125	85
with Source Code	250	169
dBC III	250	169
with Source Code	500	356
dBC III Plus	750	499
with Source Code	1500	998
LMK *Make Facility*	195	138
RPG II Combo *All three items below*	1100	875
RPG II Compiler *No Royalties*	750	625
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Screen Design Aid Utility *for RPG II*	350	309
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SideTalk *Resident Communications*	120	88
SSP/PC *Scientific Subroutine Library*	350	269
Text Management Utilities	120	88

metagraphics products

	List	Ours
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TurboWINDOW/Pascal *for Turbo Pascal*	95	79

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micro focus products

Micro Focus COBOL/2	900	729
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Micro Focus COBOL/IQ *for DOS 3.X Networks*	995	795
Micro Focus FORMS-2	295	235
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Level II Animator	195	155
Micro Focus PC-CICS	1495	1189
with Micro/SPF	1595	1269
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Micro Focus Professional COBOL	CALL	CALL
Micro Focus SOURCEWRITER	995	795
Micro Focus VS COBOL/XENIX	1495	1195

microport products

386 Unlimited License Kit	249	209
AT Unlimited License Kit	249	209
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DOSMerge386 *2-Users*	395	345
DOSMerge386 *Unlimited Users*	495	429
System V/386 Combination	799	669
386 Runtime System	199	169
386 Software Development System	499	429
Text Preparation System	199	169
System V/AT Combination	549	465
AT Runtime System	199	169
AT Software Development System	249	209
Text Preparation System	199	169
	395	295

microsoft products

Microsoft BASIC Compiler *for XENIX*	695	CALL
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Microsoft C Compiler 5.0 *w/CodeView*	450	CALL
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for XENIX	995	CALL
Microsoft Excel *New*	495	CALL
Microsoft FORTRAN *Optimizing Compiler*	450	CALL
Microsoft FORTRAN *for XENIX*	695	CALL
Microsoft Learning DOS	50	CALL
Microsoft Macro Assembler	150	CALL
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with EasyCAD	175	CALL
Microsoft Pascal Compiler	300	CALL
for XENIX	695	CALL
Microsoft QuickBASIC	99	CALL
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Microsoft Windows	99	CALL
Microsoft Windows 386 *New*	195	CALL
Microsoft Windows Development Kit	500	CALL
Microsoft Word	450	CALL
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mks products

MKS AWK	75	65
MKS RCS *Revision Control System*	189	155
MKS Toolkit *with MKS VI Editor*	139	109
MKS Trilogy *with AWK, CRYPT & Korn Shell*	119	99
MKS VI *Editor by MKS*	75	65

modula-2 language

LOGITECH Modula-2 Development System	249	199
Modula-2 Compiler Pack	99	79
Modula-2 Toolkit	169	139
LOGITECH Modula-2 Window Pkg	49	39
Macro2 *Macro preprocessor by PMI*	89	79
ModBase *by PMI*	89	79
ModGraph *by TEQNA*	50	45
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MODULA-2 with Utilities *by Stony Brook* *New*	345	299
Repertoire *by PMI*	89	75
Science & Engrg Tools *by Quinn-Curtis*	75	67
Universal Graphics Library *by Quinn-Curtis*	130	119

mouse products

LOGIMOUSE BUS *with PLUS Pkg by LOGITECH*	119	98
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with PLUS & CAD Software	189	153
with PLUS & CAD & Paint	219	179
with PLUS & First Publisher	CALL	CALL
LOGIMOUSE C7 *with PLUS Pkg, Specify Connector*	119	98
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with PLUS & CAD Software	189	153
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with PLUS & First Publisher	CALL	CALL
Microsoft Mouse *See Microsoft Section*		

other languages

ACTOR *by Whitewater Group*	495	419
CCS MUMPS *All varieties by MGlobal*	CALL	CALL
Marshal Pascal *by Marshal Language Systems*	189	155
Pascal-2 *by Oregon Software*	395	289
Personal REXX *by Mansfield Software*	125	99
SNOBOL4+ *by Catspaw*	95	80

other products

Carbon Copy Plus *by Meridian Technology*	195	159
Dan Bricklin's Demo Pgm *by Software Garden*	75	57
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MicroTEX *Typesetting from Addison-Wesley*	295	CALL
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phoenix products

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Pdisk *Hard Disk & Backup Utility*	145	99
Pfantasy Pac *Phoenix Combo*	995	595
Pfinish *Execution Profiler*	395	209
Pfix86plus *Symbolic Debugger*	395	209
PforCe *Specify C Compiler*	395	209
PforCe++ *Specify C Compiler and C++*	395	209
Plink86plus *Overlay Linker*	495	275
Pmaker *Make Utility*	125	78
Pmate *Macro Text Editor*	195	108
Pre-C *Lint Utility*	295	154
Ptel *Binary File Transfer Program*	195	108

polytron products

PolyBoost *Software Accelerator* *Special Price*	80	54
PolyDesk III	99	72
PolyDesk III Archivist	50	42
PolyDesk III Cryptographer	50	42
PolyDesk III Talk	70	52
PolyLibrarian *Library Manager*	99	89
PolyLibrarian II *Library Manager*	149	129
PolyMake *UNIX-like Make Facility*	149	129
PolyShell *Special Price*	149	105
Polytron C Beautifier	50	45
PolyXREF *Complete Cross Ref Utility*	219	185
PolyXREF *One language only*	129	109
PVCS Corporate *Version Control System*	395	329
PVCS Personal	149	129

program mgmt utilities

Interactive EASYFLOW *by Haventree*	150	125
PrintQ *by Software Directions*	89	84
Quilt Computing Combo *QMake & SRMS*	250	199
Sapiens MAKE	179	155
Sapiens MAKE & V8	439	379
Source Print *by Aldebaran Labs*	97	75
TLIB *Version Control System by Burton*	100	89
Tree Diagrammer *by Aldebaran Labs*	77	67

sco products

Complete XENIX System V *by SCO*	1295	994
Development System	595	499
Operating System *Specify XT or AT*	595	499
Text Processing Package	195	144
Lyrix *by SCO*	595	449
SCO Professional *1-2-3 Workalike for XENIX*	795	595
SCO XENIX-NET	595	495
XENIX System V 386 *by SCO*	CALL	CALL

softcraft products

Btrieve *ISAM Mgr with No Royalties*	245	169
Xtrieve *Query Utility*	245	169
Report Option *for Xtrieve*	145	89
Btrieve/N *for Networks*	595	429
Xtrieve/N	595	429
Report Option/N *for Xtrieve/N*	345	249
XQL *New*	795	CALL

text editors

Brief & dBrief Combo *from Solution Systems*	275	CALL
Brief	195	CALL
dBrief *Customizes Brief for dBASE III*	95	CALL
de *by David Livshin*	75	65
Epsilon *Emacs-like editor by Lugaru*	195	147
KEDIT *by Mansfield Software*	125	98
Micro/SPF *by PHASER SYSTEMS*	175	139
Microsoft Word	450	CALL
PC/VI *by Custom Software Systems*	149	99
SPF/PC *by Command Technology Corp*	CALL	CALL
Vedit Plus *by CompuView*	185	128

turbo pascal utilities

ALICE *Interpreter by Software Channels*	95	66
AZATAR DOS Toolkit *by AZATAR* *New*	95	85
DOS/BIOS & Mouse Tools *by Quinn-Curtis*	75	67
Flash-up *by Software Bottling* *New*	89	78
Flash-up Developer's Toolbox *New*	49	45
MACH 2 *for Turbo Pascal by Micro Help*	69	55
MetraByte D/A Tools *by Quinn-Curtis*	100	89
Science & Engrg Tools *by Quinn-Curtis*	75	67
Screen Sculptor *by Software Bottling*	125	91
Speed Screen *by Software Bottling*	35	32
System Builder *by Royal American*	150	129
IMPEX *Query Utility*	100	89
Report Builder	130	115
TDebugPLUS *by TurboPower Software*	60	49
Tmark *by Tangent Designs*	80	69
Turbo Professional *from TurboPower* *New Version*	99	79
TurboHALO *from IMSI*	95	75
TurboPower Utilities *by TurboPower*	95	78
TurboRef *by Gracon Services*	50	35
TURBOsmith *Source Debugger by Visual Age*	99	69
Universal Graphics Library *by Quinn-Curtis*	130	119

wendin products

Operating System Toolbox	99	79
PCNX *Operating system*	99	79
PCVMS *Similar to VAX/VMS*	99	79
Wendin-DOS *Multitasking DOS*	99	85
XTC *Text Editor w/Pascal source*	99	75

xenix/unix products

Btrieve *ISAM File Mgr by SoftCraft*	595	429
C-terp *by Gimpel*	498	379
c-tree *ISAM Mgr by FairCom*	395	289
dBx *with Library Source by Desktop AI*	550	419
DIRECTORY SHELL 286 *by American Mgmt Sys*	349	295
DIRECTORY SHELL 386 *by American Mgmt Sys*	495	415
Epsilon *Text Editor by Lugaru* *New*	195	147
Micro Focus Products *See Micro Focus Section*		
Microport Products *See Microport Section*		
Microsoft Products *See Microsoft Section*		
PANEL Plus *by Roundhill Computer Systems*	795	535
REAL-TOOLS *Binary Version by PCT*	99	89
Complete Source Version	999	729
RM/COBOL *by Ryan-McFarland*	1250	949
RM/FORTRAN *by Ryan-McFarland*	750	549
SCO Products *See SCO Section*		

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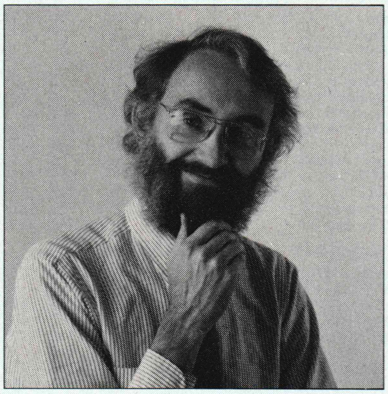
SWAINE'S FLAMES



It will be seen that this mere painstaking burrower and grub-worm of a poor devil of a sub-sub appears to have gone through the long Vaticans and street-stalls of the earth, picking up whatever allusions to whales he could anyways find in any book whatsoever, sacred or profane. Therefore you must not, in every case at least, take the higgledy-piggledy whale statements, however authentic, in these extracts, for veritable gospel cetology.

—Herman Melville.

Ahab, standing on the deck of Pequod and searching for the great white whale, overlooked the real monster.

Ben, an editor for another magazine, recently moved to the West Coast. Drawn by the California curls, he went out to walk the waves. Last week the ocean drove his surfboard into his face.

It's been nearly seven years since I moved to the Coast, but I still walk out on the rocks regularly to stand in awe of the big blue beast.

At last fall's Comdex, IBM rolled in with an announcement of the delivery of OS/2 and word that it will be promoting its proprietary Extended Edition of OS/2 over the Standard Edition. The Comdex daily declared the show Very Blue, while several frolicking whales spouted their support.

Among the whales, Lotus Development Corp. announced Agenda. Agenda is the information manager that Jerry Kaplan went to Lotus to develop. It is what he calls an item/category database: the items are short, free-form, textual entities, which the user can assign to points in a user-defined, evolving hierarchy of categories. Agenda could be wildly successful if it sufficiently models the näive view of computers held by many pre-users: that one should be able to type arbitrary information into the machine and retrieve it on demand.

Ashton-Tate's chairman, Ed Esber, had left no doubt as to who would define the dBASE standard when he dared dBASE add-on and compiler vendors to "make his day," which they could do by challenging A-T's claim on the dBASE language (the language itself, not just A-T's implementation). So it came as no surprise to see Marty Winston of Wallsoft at Comdex handing out make-my-day buttons decorated with the international red-circle-and-backslash negation symbol. (It was Winston who brought dBASE aftermarket companies together in a dBASE Standards Committee.) Can a language definition be a product? Esber has not only thrown down the gauntlet to the aftermarket companies but also challenged the industry to deal with this tricky question.

Despite the lukewarm response to IBM's RT, you can find RISC technology implementations for just about any broad-based hardware. Shortly before Comdex, Sun announced its SPARC (Scalable Processor ARChitecture) RISC architecture and by Comdex had licensed the technology to over 40 companies, including Arete. Products based on the Inmos transputer parallel RISC processors are also proliferating. Atari, which incidentally would have won any Most Outrageous Product Name at Comdex competition with its Moses Promiselan, demonstrated a prototype of the Abaq transputer, which can act as a backend for an Atari ST and provide mondo MIPS number crunching and near-photographic graphics. Levco, now a division of Scientific Micro Systems, announced the formation of a TransLink Transputer Developers Group to support developers using its transputer modules in Macs.

Comdex offered a few new implementations of familiar languages. Ryan-McFarland, now a division of Austec, announced an OS/2 version of its ANSI-77 FORTRAN, Lahey offered a PC ANSI-77 FORTRAN for $95, and Prospero had an ANSI-77 FORTRAN for GEM. A number of new Modula-2 implementations or versions were announced, including a new version of the well-regarded Logitech compiler, new FTL versions for several machines, and OXXI's Benchmark Modula-2 for the Commodore Amiga. California Software Products has ported RPG II to PCs. And Borland unloaded a number of language announcements, including Turbo Pascal 4.0.

Meanwhile amid the flotsam and jetsam of the show, I kept sighting ex-editors of ex-programmers' magazines who had jumped ship as their magazines sailed into strange waters. Finally, heading for the pressroom one last time, I ran into Scott Mace, who, having been with *InfoWorld* since before I moved to the Coast, must be the longest-tenured scribe for any personal computer industry publication. A real journalist and a survivor.

And Ben was in the pressroom, the stitches now out, working on his notes.

Michael Swaine

Michael Swaine
editor-in-chief

How A C Programmer Became A Screen Star

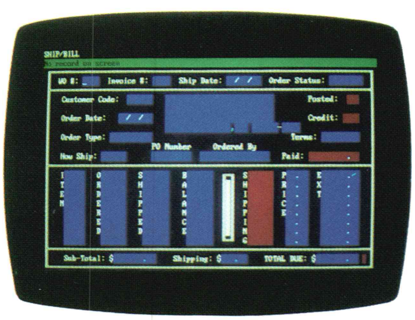
Screens, the Visible Part of Your Program.

A program is often judged by how well the screens are executed. However, the real creativity lies in what goes on behind the screens.

ScreenStar is a product that allows your real creativity to light up the screen. It reduces costly screen, window, and data validation development time.

You Take the Bows, We Write the Code.

Our natural drawing commands allow you to paint any screen imaginable. Press one key when you are satisfied and ScreenStar produces concise, commented, ready-to-compile code. This allows immediate testing of the I/O screens, including smooth, even scrolling between multiple screens.



Create or capture complex screens with data-entry filters built in.

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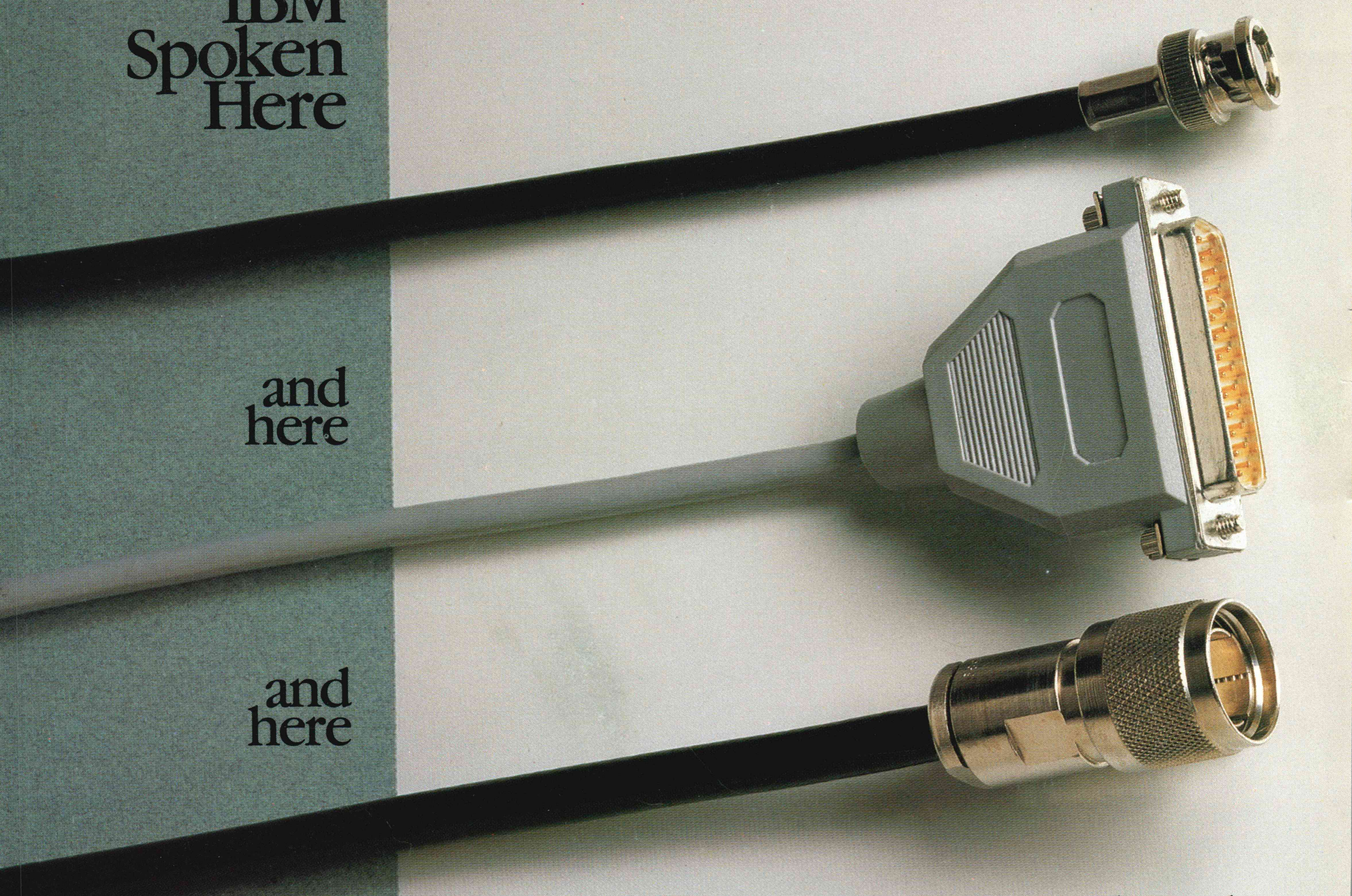

and here

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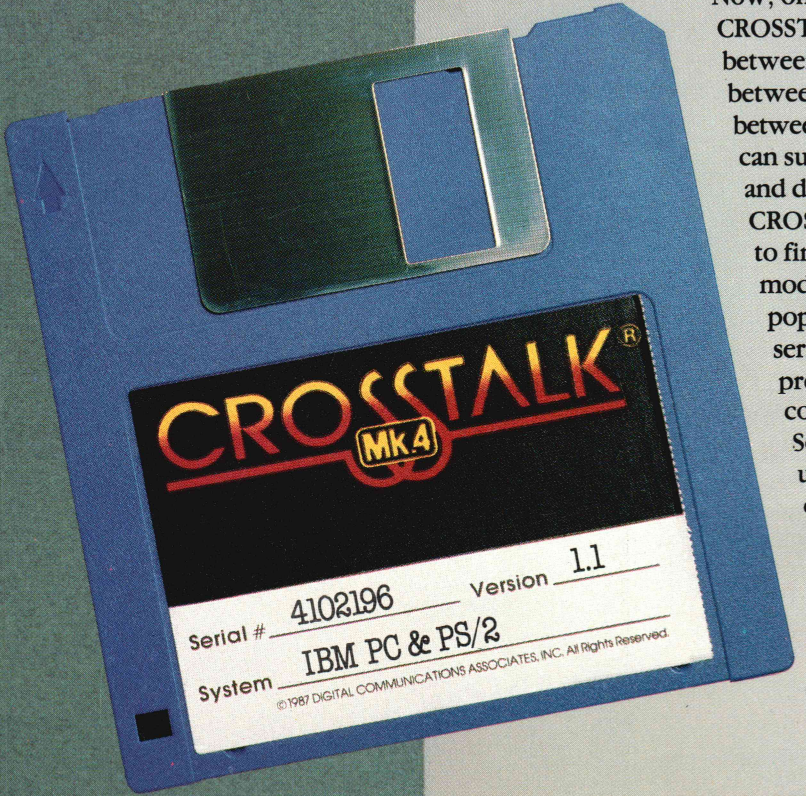

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